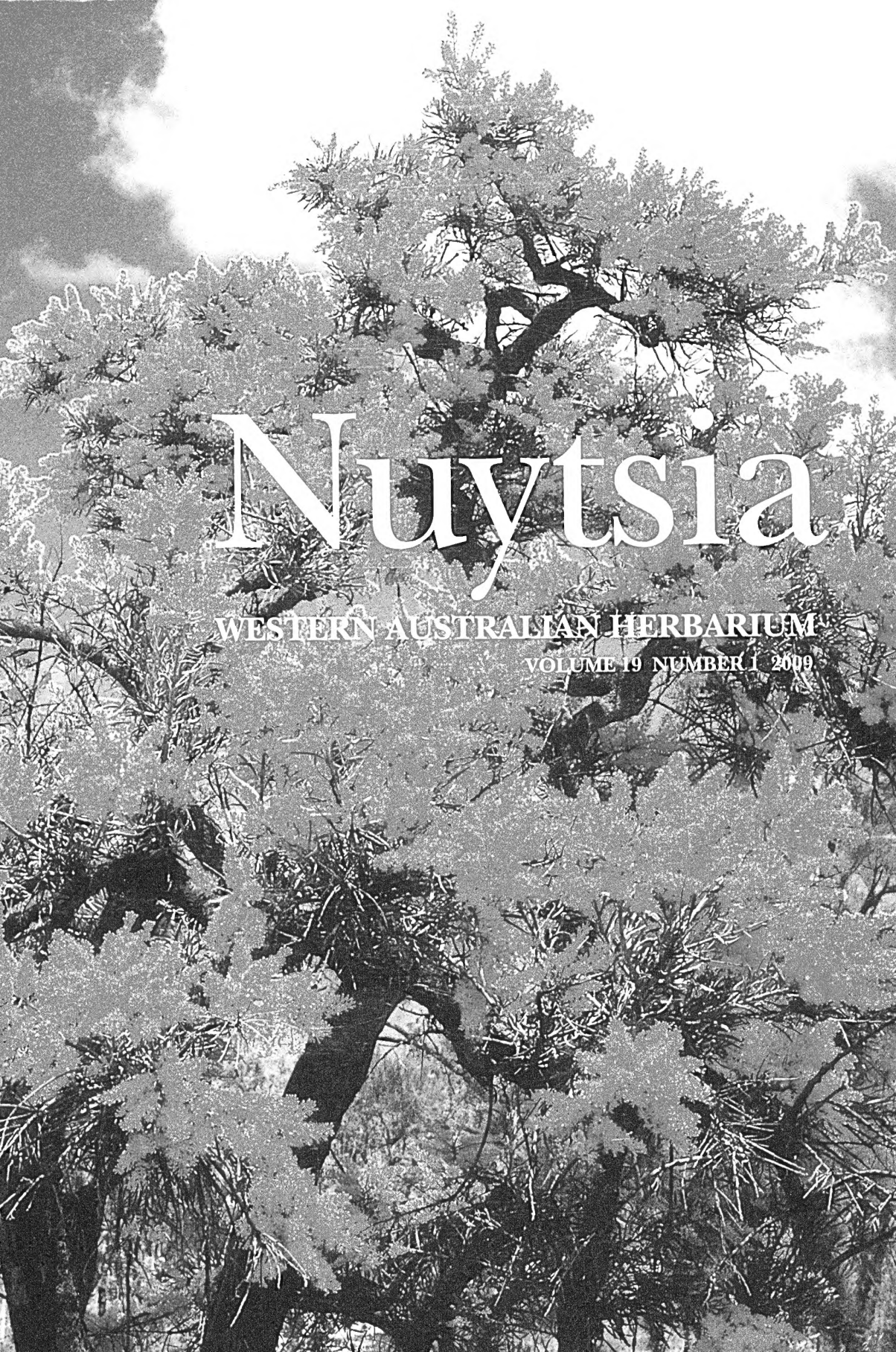

Nuytsia

WESTERN AUSTRALIAN HERBARIUM

VOLUME 19 NUMBER 1 2009

Cover

Nuytsia floribunda (Labill.) R. Br. ex Fenzl (Loranthaceae) – the Western Australian Christmas Tree is one of the few arborescent mistletoes in the world. This endemic tree is a semi-parasite common in sandy soil from the Murchison River to Israelite Bay. The journal is named after the plant, which in turn commemorates Pieter Nuijts, an ambassador of the Dutch East India Company, who in 1627 accompanied the 'Gulde Zeepaard' on one of the first explorations along the south coast of Australia.

Photograph: A.S. George

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DEPARTMENT OF ENVIRONMENT AND CONSERVATION
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Calytrix gomphrenoides (Myrtaceae), a new species from the Kimberley Region of Western Australia

Matthew D. Barrett[1], Lyn A. Craven[2] and Russell L. Barrett[1,3]

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Abstract

Barrett, M.D., Craven, L.A. & Barrett, R.L. *Calytrix gomphrenoides* (Myrtaceae), a new species from the Kimberley Region of Western Australia. *Nuytsia* 19(1): 1–8 (2009). *Calytrix gomphrenoides* M.D.Barrett & Craven is described as a new species from sandstone pavements of the north-west Kimberley Region of Western Australia. It is apparently most closely related to *C. inopinata* Craven in the *C. exstipulata* DC. alliance. Emendations to a published key and notes on related species are provided.

Introduction

Calytrix Labill. (Myrtaceae: Chamelaucieae) was revised by Craven (1987). Since then four species and two subspecies have been added to the genus from south-west Western Australia (Craven 1990, Keighery 2004) and one from the Northern Territory (Craven 1991). During a recent field trip to the remote Prince Regent River area, one of us (MDB) found an unusual long-hypanthiate *Calytrix* that differed in several respects from *C. exstipulata* DC., the only known Kimberley species with a long hypanthium. On examination, the taxon proved sufficiently distinct to warrant specific recognition, and is here described as a new species. Subsequent searches have discovered several additional populations, and examination of herbarium material revealed one earlier collection from 1997. *Calytrix gomphrenoides* is restricted to treeless sand flats over sandstone, as are many other localised microphyllous Myrtaceae in sandstone areas of north-western Australia such as *Calytrix megaphylla* (F. Muell.) Benth., *C. micrairoides* Craven, *Petraeomyrtus punicea* (Byrnes) Craven, and *Thryptomene remota* A.R.Bean (Bean 1997; Craven 1980, 1987, 1990, 1991, 1999). Many new taxa have been discovered in the Kimberley in similar habitats in recent years, with species recently described in *Acacia* (Lewington & Maslin 2009), *Bossiaea* (Ross 2006) and *Micraira* (Barrett & Barrett 2005), and with additional taxa from many genera in preparation by a number of authors.

Methods

All measurements and illustrations were made from dried material. Descriptive terminology follows Craven (1987). The distribution map was created in DIVA-GIS Version 5.2.0.2. (http://www.diva-gis.org) using coordinate data from personal collections, and show *Interim Biogeographic Regionalisation for Australia* (*IBRA*) *Version 6.1* boundaries (Department of the Environment, Water, Heritage and the Arts 2008).

The new species is numbered to facilitate placement in the revision of *Calytrix* (Craven 1987, 1990, 1991).

Taxonomy

29B. Calytrix gomphrenoides M.D.Barrett & Craven, *sp. nov.*

Frutex multicaulis lignotuberosus usque 50 cm altus. Folia caulis (2–)4–10 mm longa, linearia, sectione transversali obtriangularia. Folia floralia alis membranaceis partim usque perfecte. Flores in fasciculis terminalibus. Bracteolae membranaceae, carinis laciniatis, jam liberae et discretim deciduae. Hypanthium glabrum, 10-costatum, a stylo discretum paene omnino, 9–13 mm longum. Petala alba erubescens adaxialiter. Stamina 16–18, 1-seriata.

Typus: Near falls on south arm of Bachsten Creek, Kimberley Region, 15° 58' 00" S, 125° 19' 30" E, Western Australia, 31 January 1999, *M.D. Barrett* 692 (*holo*: PERTH 06359728, *iso*: CANB, MEL, DNA, K, BRI, NSW).

Multi-stemmed lignotuberous *shrub* to 50 cm tall, glabrous; apices of stems usually not continuing growth (growth continuing from below flowering head), sometimes continuing from apices. *Bud scales* absent. *Leaves* alternate, sparse on main stems becoming dense toward apices of short branches, appressed to ascending on stems, ascending to spreading on branches, sometimes deciduous on main stems; *stipules* to 0.25 mm long; *petiole* 0.9–1.2 mm long; *stem leaves*: blade linear, glabrous, (2–)4–10 mm long, 0.4–0.8 mm wide, straight, broadly obtriangular in transverse section, margin entire, base slightly narrowing to petiole, apex acute and mucronulate, with a row of oil-glands on each side of midrib abaxially and adaxially; *floral leaves* 6–8 mm long, 1.0–1.6 mm wide, with a pale membranous wing 0.3–0.6 mm wide on each side along basal half to entire length of leaf, otherwise as for stem leaves. *Inflorescences* many, in dense terminal heads of 15–40 flowers. *Peduncle c.* 0.3 mm long, apex slightly extending, with enations on the inner edge. *Bracteoles* chartaceous, almost completely free, connate in proximal *c.* 1 mm, deciduous after anthesis and falling separately, narrowly obovate, body 6.5–8.0 mm long, 2.2–2.4 mm wide, straight, distal half with a strong, laciniate keel, bordered either side by a row of translucent glands, margin erose near the subacute apex and with an apiculum 1.4–2.2 mm long. *Hypanthium* 10-ribbed, almost completely free from the style, 9–13 mm long, cylindrical (slightly swollen in the ovary region) and tapering toward the base, ovary region *c.* 0.6 mm wide and terete in section, free region 4–6 mm long, *c.* 0.6 mm wide, slightly flared at the apex to 0.8 mm wide; *staminal disc* produced inward, the inner edge sometimes producing a collar. *Calyx segments* connate at the base (for up to 0.7 mm); body suborbicular to ovate (excluding awn), 1.7–2.5mm long, 2.0–2.5 mm wide, margin erose, apex acute; awn 11–12 mm long; minutely scabrid, curled in bud. *Petals* narrowly ovate, 5.5–7.2 mm long, 1.7–1.9 mm wide, apex acute, with sparse embedded translucent glands, adaxially white soon becoming pink, the basal region becoming dark red

after anthesis, abaxially suffused pink around reddish veins and with broad white margins, sometimes drying yellow. *Stamens* 16–18, 1-seriate; filaments white becoming pink then dark red, 3.5–9 mm long, of varying lengths in single flower; *anthers* all fertile, 0.25–0.40 mm long, the connective prominent, with 4 gibbous glands on abaxial face. *Style* persistent, exserted for 5–6.5 mm; *stigma* minute, narrower than style, minutely papillate. *Mature seed c.* 4 × 0.8 mm, very narrowly obovoid. (Figures 1, 2)

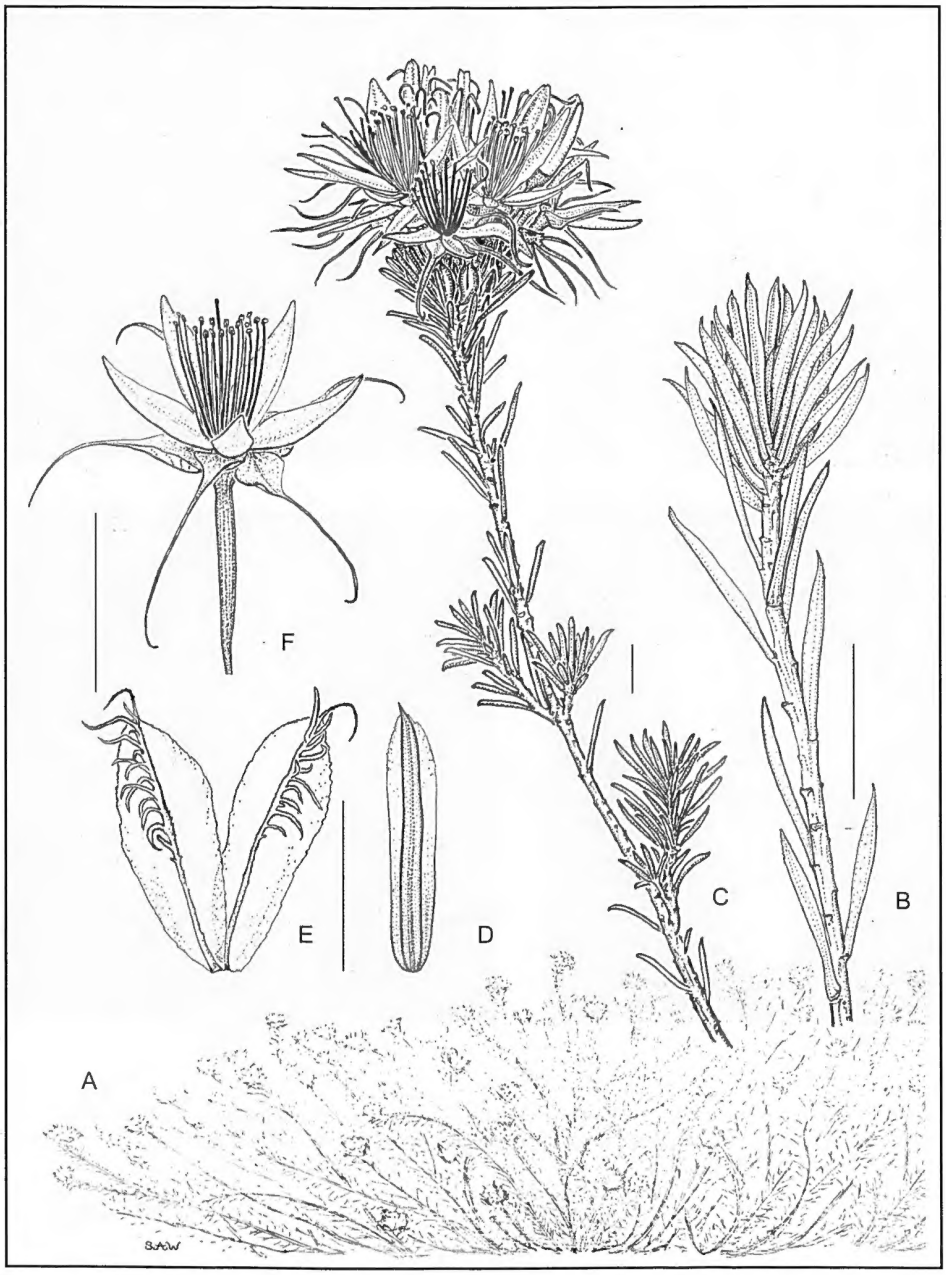

Figure 1. A–F. *Calytrix gomphrenoides*. A – habit; B – leafy stem; C – flowering stem; D – floral leaf; E – pair of bracteoles; F – flower. All from *M.D. Barrett* 433 (PERTH). Drawn by Sharyn Wragg. All scale bars = 1 cm.

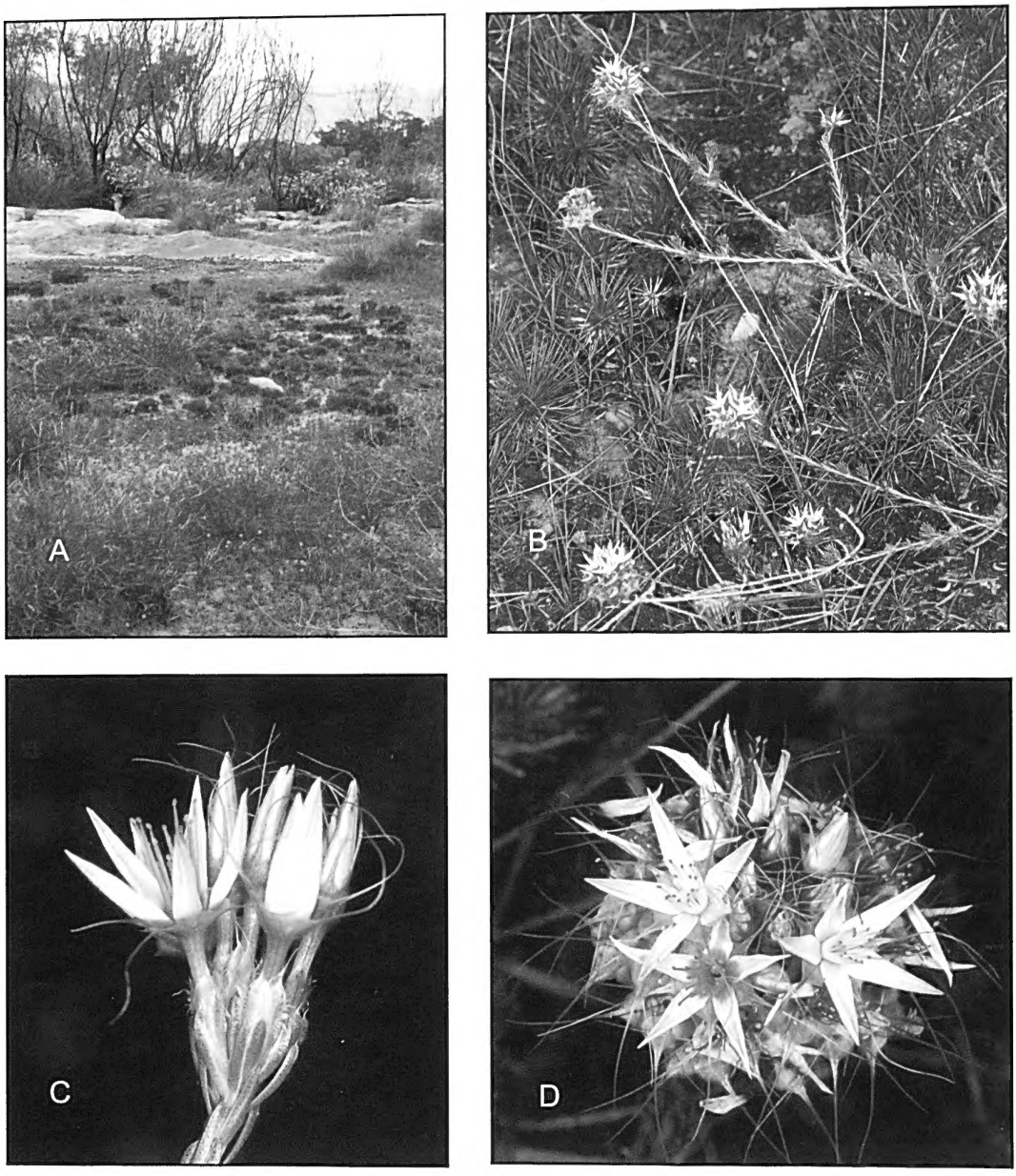

Figure 2. A–D. *Calytrix gomphrenoides*. A – sandstone pavement habitat with plants on foreground (*R.L. Barrett & M.D. Barrett* RLB 3864); B – habit with *Borya subulata*; C – flowering stem; D – flower cluster; B–D from *R.L. Barrett & M.D. Barrett* RLB 3774, both at PERTH.

Other specimens examined. WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] Gardner Region: Mt Bomford, 19 Mar. 1999, *M.D. Barrett* 433 (CANB; PERTH); north arm of Bachsten Creek Gorge, 30 Jan. 1999, *M.D. Barrett* 684 (PERTH); north arm of Bachsten Creek Gorge, 3 Feb. 1999, *M.D. Barrett* 740B (PERTH); Mt Bomford, 25 Jan. 2000, *M.D. Barrett* 876 (CANB, DNA, PERTH); N of Kings Cascade, Prince Regent Nature Reserve, 20 Jan. 2003, *M.D. Barrett & R.L. Barrett* 1348 (PERTH); ESE of Mt Agnes, 21 Jan. 2003, *M.D. Barrett & R.L. Barrett* 1359 (AD, PERTH); south arm of Bachsten Creek, 23 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3774 (DNA, MEL, NSW, PERTH); near Youwanjela Creek, 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3864 (DNA, NSW, PERTH); E of Mt Trafalgar, Prince Regent Nature Reserve, 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3953 (CANB, PERTH); Mt Bomford, 13 May 1997, *S.D. Hopper* 8346 (PERTH).

Distribution. Known only from ranges around the Prince Regent River, north-west Kimberley Region, Western Australia (Figure 3), where it occurs in relatively few localised populations. Extensive and widespread but by no means exhaustive surveys of pavements in the NW Kimberley have been made by MDB & RLB. From these surveys we estimate that the distributional extent of *C. gomphrenoides* is probably fairly accurate, and that we have found perhaps half of the total populations. All but one of the collections to date have been made using a helicopter for field access.

Habitat. Calytrix gomphrenoides has only been found growing in shallow sand over elevated sandstone pavements, in association with *Acacia barrettiorum*, *A. kelleri*. *A. retinervis*, *A.* cf. *translucens*, *A. vincentii*, *Borya subulata*, *Cochlospermum fraseri*, *Drosera paradoxa*, *D.* aff. *paradoxa*, *Eriachne ciliata*, *Eriocaulon* sp., *Goodenia arachnoidea*, *G.* aff. *gloeophylla*, *G. psammophila*, *Heliotropium* spp., *Hibiscus superba*, *Lechenaultia filiformis*, *Micraira brevis*, *M. lazaridis*, *Portulaca* spp., *Rhynchospora* sp., *Sauropus* sp., *Solanum petraeum*, *Sowerbaea alliacea* and *Triodia* spp.

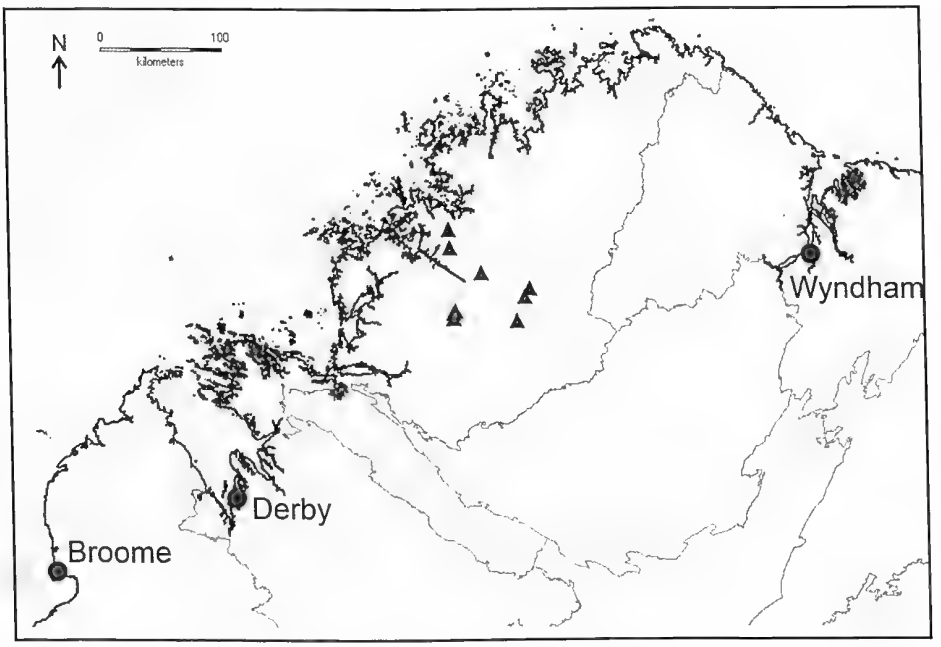

Figure 3. Distribution of *Calytrix gomphrenoides* (▲) in the Kimberley region of Western Australia.

Phenology. Flowering January to May.

Conservation status. Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora: Priority Four. Potential habitats are considered to have been adequately surveyed. The species is not under any immediate threat, but is only known from about ten populations. Several populations are estimated to contain over 1000 plants. The species is conserved in the Prince Regent Nature Reserve.

Plants have a lignotuber and are capable of resprouting after fire. The vegetation on the pavements is often too sparse to carry a hot fire, so fire appears to pose little immediate threat to known populations. Fire may, however, have shaped the current restricted distribution pattern of this species and frequent fires may have a detrimental effect on small populations.

Etymology. The specific epithet '*gomphrenoides*' refers to the superficial similarity to *Gomphrena canescens* R.Br. (Amaranthaceae), in particular the multi-stemmed habit with terminal, hemisperical clusters of pink flowers. In addition, the membranous-winged floral leaves and chartaceous bracteoles have a superficial similarity to the translucent bracts and bracteoles of *Gomphrena*.

Affinities. Following the informal species groupings proposed by Craven (1987), the 1-seriate stamens, absence of bud scales and long hypanthium place this species in the *C. decandra* group. However, the similarity between *C. surdiviperana* Craven and *C. inopinata* Craven with 2–several-seriate and 1-seriate stamens respectively suggests that the number of stamen series is not entirely satisfactory to delimit the *C. decandra* group from the *C. exstipulata* group, both of which are in the *C. exstipulata* alliance (see Craven 1991). Craven (1991) accordingly suggested an intermediate position between the two groups for *C. surdiviperana* and *C. inopinata*. *C. gomphrenoides* appears to be a further intermediate species.

Within the *C. exstipulata* alliance, *C. gomphrenoides* appears to be related to a group of species restricted to sandstone pavements or crevices on sandstone in north-west Australia. This group has free bracteoles, longer leaves (compared with *C. exstipulata*), and stipules present and consists of *C. surdiviperana*, *C. inopinata*, *C. mimiana* Craven and *C. megaphylla* (F. Muell.) Benth. The new species differs from these four species in having laciniate keels on the bracteoles, membranous-winged floral leaves, and the apices of stems usually not continuing growth. It also differs from the first two in having a glabrous (vs. pubescent) hypanthium and having shorter stipules and from all except *C. inopinata* in having 1-seriate (vs. (1-)2-3-(4-)seriate) stamens and flowers which are white fading pink (vs. pink fading darker). The petal colour and 1-seriate stamens suggest *C. inopinata* may be the closest relative of *C. gomphrenoides*.

The new species can be distinguished from all other northern *Calytrix* species (except some specimens of *C. carinata* Craven) by the ± free bracteoles with a strong laciniate keel, and further (except *C. inopinata*) by the 1-seriate stamens (partly 1-seriate in some species). The only sympatric species with a long hypanthium is *C. exstipulata*, which differs in lacking stipules, having shorter leaves, and bracteoles fused into a cheiridium with a weaker, entire keel. The habit (low multi-stemmed shrub, resprouting from a lignotuber) is unique in northern species, although the resprouting habit is also a feature of *C. megaphylla*.

Notable features are the habit (multi-stemmed, resprouting from a lignotuber), stem apices not continuing growth, 1-seriate stamens, laciniate-keeled free bracteoles, petals white, fading pink, and the winged floral leaves.

Calytrix gomphrenoides keys out in Key 2 in Craven (1987) amongst *C. decandra, C. verruculosa*, and *C. fraseri*. The following should be inserted after the second lead in couplet 9:

9. Stipules not prominent, less than 0.75 mm long, usually 1-paired (sometimes 2-paired in floral leaves).
9A. Bracteole with a laciniate keel. Apices of flowering stems usually not continuing growth. Floral leaves with a membranous wing, different to stem leaves. ..... **29B. C. gomphrenoides**
9A: Bracteole smooth or ridged apically, not laciniate. Apices of flowering stems continuing growth. Floral leaves not winged, undifferentiated from stem leaves.

Notes. Calytrix. gomphrenoides resprouts after fire with numerous burnt stems having been observed at the base of live plants. The lignotuber extends to 10 cm below ground level and terminates at ground level. The lignotuber may be branched at its base into several units, which may eventually separate. Each unit is *c.* 8 cm long by 2 cm diameter (up to 10 × 5 cm), with epicormic buds along its entire length. Growing stems are 2–10 from each lignotuber unit, mostly from the apex. Each ramet has a primary root at the base of the lignotuber; the root is tapering, twisted, lacking epicormic buds, and is strongly demarcated from the thickened lignotuber. These primary roots may represent taproots, but grow laterally, possibly constrained by sandstone bedrock. Secondary laterals are thin and isodiametric.

Calytrix exstipulata co-occurs with *C. gomphrenoides* at the Bachsten Falls (south arm) site, where it is associated with rocks rather than its usual habitat of sand flats (possibly evading fire). Elsewhere in the Kimberley, *C. exstipulata* does occur on sand.

The leaves of the Mt Bomford specimens are shed as they dry on pressed material. Whether the leaves are deciduous *in situ* over the dry season is unknown.

Acknowledgements

Our grateful thanks to Sharyn Wragg for preparing the illustration. The field trips to the Kimberley Region were undertaken with financial support of the Botanic Gardens and Parks Authority. Stephen Hopper generously allowed access to his personal collecting records. Anne and John Koeyers are thanked for permission to access sites on Drysdale River Station. Thanks are due to our various pilots, particularly Butch Maher, for safely transporting MB and RB to these remote sites.

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Tetratheca plumosa (Elaeocarpaceae), a new species closely allied to *Tetratheca similis* from south-west Western Australia

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Abstract

Butcher, R. *Tetratheca plumosa* (Elaeocarpaceae), a new species closely allied to *Tetratheca similis* from south-west Western Australia. *Nuytsia* 19(1): 9–16 (2009). *Tetratheca plumosa* R.Butcher *sp. nov.*, was collected from private property near New Norcia in 2007 and confirmed to be a new species in 2008. This species is closely allied to *T. similis* Joy Thomps., but differs significantly in having elongate, plumose, gland-tipped hairs on the ovary. *Tetratheca plumosa* is described herein and its affinities discussed. Illustrations and a distribution map are provided.

Introduction

The genus *Tetratheca* Sm. was described by Smith in 1793 from *T. juncea* Sm., a New South Wales endemic species. By 1957 53% (26 species) of the currently recognised species had been described by a variety of authors (Smith 1804; Labillardière 1805; Endlicher 1837; Cunningham 1825; Lindley 1838, 1839; Steetz 1845; Turczaninow 1852; Schuchardt 1853; Hooker 1855; Bentham 1863; Mueller 1865, 1876, 1882; Blakely 1925; Black 1929; Willis 1957). Taxonomic revision of the genus by Thompson in 1976 saw 13 new species described, eight of these endemic to Western Australia. One of these, *T. elliptica* Joy Thomps., is no longer current (T.D. Macfarlane *in sched.*; Western Australian Herbarium 1998–). Recent alpha taxonomic studies have increased the size of the genus to 49 species through the description of 11 new Western Australian endemics (Alford 1995; Butcher & Sage 2005; Bull 2007; Butcher 2007a, 2007b, 2007c, 2008), many with highly restricted distributions. The description of *T. plumosa* R.Butcher raises the number of species of *Tetratheca* to 50, 70% of which are endemic to Western Australia.

Tetratheca plumosa was discovered during a vegetation survey of private land near New Norcia by Moore Catchment Council (MCC) and Department of Environment and Conservation (DEC) personnel in 2007. The specimen, collected from private property, was originally referred to *T. similis* Joy Thomps. due to its superficial similarity to that species, but was identified as an undescribed species in 2008 when close examination revealed elongate, plumose, gland-tipped hairs on the ovary. Hairs such as these have not been recorded in the genus before and are so remarkable that recognition of this taxon at species rank is considered appropriate.

Methods

All *Tetratheca* specimens at AD, MEL and PERTH, and specimens of Western Australian species on loan from NSW, were examined. The description is based on herbarium specimens, reconstituted flowers, fresh samples and material preserved in 70% ethanol. Herbarium acronyms follow Holmgren and Holmgren (1998–). The distribution map was created using the freeware program DIVA-GIS freeware Version 5.0.2.0 (http://www.diva-gis.org), from PERTH specimen data, and shows *Interim Biogeographical Regionalisation for Australia (IBRA) Version 6.1* boundaries (Department of the Environment, Water, Heritage and the Arts 2008).

Taxonomy

Tetratheca plumosa R.Butcher, *sp. nov.*

Tetrathecae simili Joy Thomps. affinis sed ovario pilis glanduliferis longis plumosis et colore staminum omnino purpureo notabilis.

Typus: south-west of New Norcia [precise locality withheld for conservation reasons], 17 October 2008, *R. Butcher & L. Kelly* RB 1311 (*holo*: PERTH 07904924; *iso*: CANB, K, MEL, NSW).

Tetratheca sp. New Norcia (D. Rayner *et al.* RH 807-20), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 13 October 2008].

Spreading *sub-shrub*, 0.07–0.2 m high, 0.3–0.4 m wide. *Stems* numerous from base; branches alternate or several arising from a node, slender, terete, straight, indeterminate, 0.5–0.7 mm wide in flowering region; younger stems light green, striate; older stems light green to olive green, rugulose to irregularly striate, developing a light grey-brown, thin bark; all stems densely pubescent with wavy, commonly decurved hairs, 0.3–0.5 mm long, and moderately dense, stiff, ±patent, tubercle-based setae, which are 1–2.5 mm long, red ageing to orange-brown, and fall away on older stems to leave tubercles and hair bases. *Leaves* 3-whorled, persistent, moderately spaced, ascending when young, spreading when mature; petiole indistinct, flattened with a prominent mid-vein, 0.2–0.5 mm long, yellowish green, with setae in the stipular position and on petiole base, not glaucous; blade narrowly ovate to ovate, occasionally elliptic, 2.1–10.5 mm long, 1.2–6 mm wide; apex obtuse to rounded, occasionally with a short point; base tapering into petiole; margins usually shortly lobed, flat to undulate, usually recurved in the area between the lobes which terminate in long (1.9–2.8 mm), stiff, tubercle-based setae, which are red ageing to orange-brown; adaxial surface mid- to dark green, hirtellous to hirsute, frequently slightly glaucous; abaxial surface dull, very pale green, usually pubescent, the hairs concentrated along mid-vein, glabrescent, not glaucous. *Flowers* solitary in upper leaf axils, often three at a node. *Bracts* apparently paired, linear to lanceolate to ovate, 0.4–1 mm long, 0.2–0.4 mm wide, pink-red to red; adaxial surface concave, glabrous or with scattered short simple hairs; abaxial surface sub-glabrous, with a few hairs at apex and near margins. *Pedicels* straight to gently curved, hooked at apex, lengthening as flowers develop, 17–34 mm long, 0.3–0.45 mm wide, pink-red to magenta-purple, pubescent, not glaucous, very finely striate, uniform in width along length then expanding abruptly at apex into a thickened, ±circular, pubescent receptacle 1.3–1.8 mm wide. *Calyx* segments commonly 5, less commonly 6, rarely 7, inserted inside receptacle rim, the base thickened and folded with the thickened portion on top of the rim, deciduous, ovate, 1.8–2.5 mm long, 0.9–1.3 mm wide, strongly concave in TS; apex acute to acuminate; margins flat; outer surface pink-red to magenta-purple,

glabrous; inner surface with a few, fine, short hairs inside margin and towards apex; mid-vein thickened. *Petals* commonly 5, less commonly 6, rarely 7, deciduous, obovate with an elongate base to broadly obovate, 7.5–11.5 mm long, 4.3–7.7 mm wide with the widest point at 5.8–7 mm (*c.* 1/3–1/4 from the apex), dark pink with purple-black patch at base, this ±trifid at apex with the central peak elongated, peaks following main veins for a short distance; apex broadly rounded with a small triangular fold from centre. *Stamens* commonly 10, less commonly 12, rarely 11, 13 or 14, 3–3.7 mm long, all free; filaments thick, compressed, obliquely angled, 0.2–0.5 mm long, purple, glabrous; anther body very gently curved from the filament on the inner edge then incurved into the tube, outer edge distended a little at base then broadly curved from filament and incurved into the tube, 1.6–2.2 mm long, purple, glabrous; anther tube very gently curved along its length, 1.2–1.8 mm long, orifice narrow to moderately broad, oblique to shortly two-lipped, lower lip slightly longer than upper lip, purple, glabrous. *Ovary* ovate to elliptic, tapering into style at apex, compressed, slightly thickened at base, 1.5–1.7 mm long, 1.2–1.4 mm wide, green, densely covered with short, simple hairs externally and with the faces of the ovary also densely covered with plumose, gland-tipped hairs, these tapering from base to apex, 0.6–1.7 mm long, colourless to very pale pink, with lateral hairs in lower half to two-thirds, glabrous inside loculi; *style* straight to kinked in mid-region, thick, tapering towards apex, 1.6–2.2 mm long, pink-red becoming pale towards apex, pubescent in lower half to two-thirds; *stigma* simple, sometimes shortly tufted; *ovules* 2, 1 in each locule, attached near the apex of the septum bya swollen, colourless placenta. *Fruit* not seen. *Seed* not seen. (Figure 1)

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 17 Oct. 2008, *R. Butcher & L. Kelly* RB 1312 (HO, PERTH 07904916); 23 Aug. 2007, *D. Rayner, S. Clune & L. Kelly* RH 807-20 (PERTH 07845685).

Distribution and habitat. To date, this species has only been collected from private property *c.* 10 km south-west of New Norcia, which is *c.* 135 km north-east of Perth (Figure 2). *Tetratheca plumosa* grows in an upland position at the base of low lateritic breakaways in and on the edge of *Eucalyptus wandoo/Corymbia calophylla* woodland. Associated vegetation is open, tall *Banksia* spp. shrubland over dwarf shrubs of *Calothamnus* sp. and *Hibbertia* sp. The majority of *T. plumosa* plants seen grew in an open situation amongst and under plants of *Hibbertia.*

Phenology. Collected in flower in late August and mid-October, with newly initiated fruits seen in October.

Etymology. From the Latin *plumosus* (feathery) in reference to the diagnostic plumose, gland-tipped hairs covering the ovary.

Conservation status. Recently listed as Priority One under DEC Conservation Codes for Western Australian Flora, as *Tetratheca* sp. New Norcia (D. Rayner *et al.* RH 807-20).

Affinities. Tetratheca plumosa is remarkably similar to *T. similis* and *T. pilifera* Lindl. in having stems covered with short, curved, simple hairs and long, stiff, dark-coloured setae, three-whorled, ovate leaves with shortly lobed, long-setose margins, long pedicels that are strongly curved at the apex below a distinct receptacle, and glabrous, thickened calyx segments which are inserted inside the receptacle rim. These latter species share the characters of having glabrous abaxial leaf surfaces, small, 4- or 5-merous flowers and the ovary covered with short, simple hairs only. Molecular cladistic analysis of nuclear ribosomal Internal Transcribed Spacer (ITS) sequences resolved *T. similis* and *T. pilifera* as moderately supported sister taxa (77% bootstrap; 0.98 Bayesian posterior probability)

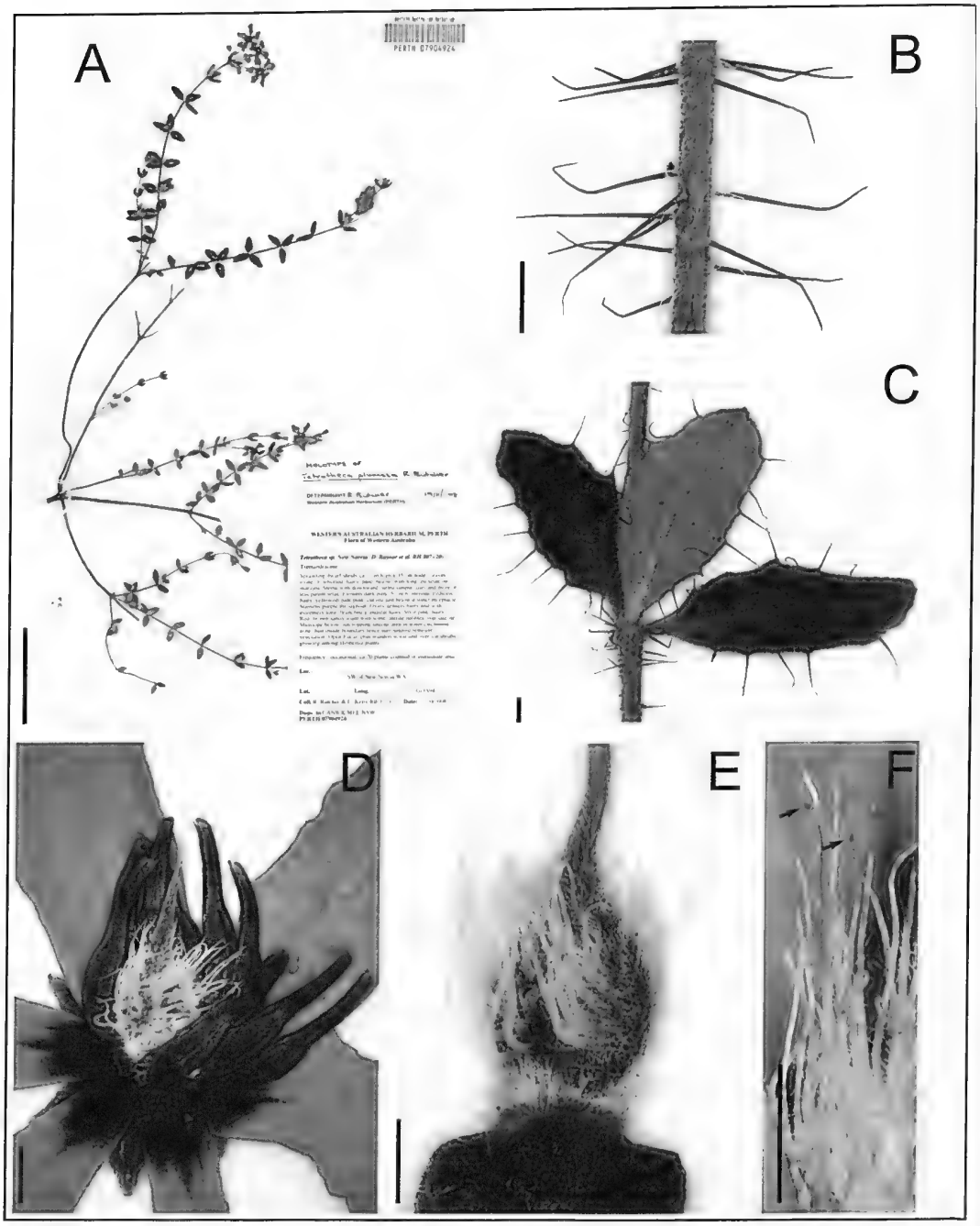

Figure 1. *Tetratheca plumosa*. A – holotype; B – stem detail showing short, curved simple hairs and long, stiff, patent, tubercle-based setae; C – leaves showing whorled phyllotaxis, discolorous surfaces, shortly lobed margin with stiff setae and setae on petiole; D – pressed flower detail showing stamen morphology and colour, the dark spot with a ±trifid apex at the base of petals and the gynoecium; E – gynoecium showing green ovary, pink style and indumentum of both short, simple hairs and elongate, plumose, glandular hairs; F – detail of plumose hairs showing morphology and minute, apparently caducous, glandular tips (arrowed). A–E from *R. Butcher & L. Kelly* RB 1311; F from *D. Rayner et al.* RH 807-20. Scale = 5 cm (A); 1 mm (B–D); 0.5 mm (E–F).

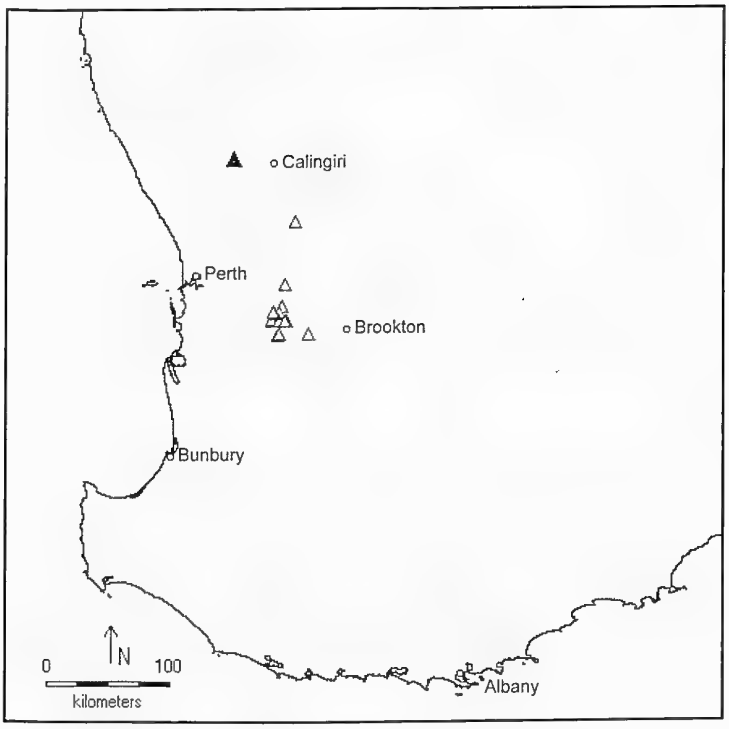

Figure 2. Distribution of *Tetratheca plumosa* in south-west Western Australia (▲). The relative distribution of *T. similis* is also shown (△).

within a polytomy of Western Australian species, but the relationships hypothesised through *trn*L-*trn*F chloroplast sequence analysis were incongruent: *T. pilifera* placed as weakly supported (54% bootstrap; 0.97 Bayesian posterior probability) sister to *T. parvifolia* Joy Thomps. and *T. similis* fell within an unsupported clade (52% bootstrap; 0.76 Bayesian posterior probability) containing *T. efoliata* F.Muell. and *T. paynterae* Alford, towards the base of the tree (McPherson 2008). Within this group of species, *T. pilifera* is distinctive in having purple flowers and stamens with long, slender filaments, yellow anther body and extremely short and broad anther tubes (see Thompson 1976: 150, Fig. 4), similar to those seen in *Tremandra* DC.

Tetratheca plumosa is most similar to *T. similis*, but can be distinguished by its ovary indumentum (pubescent with long, plumose, gland-tipped hairs, compared with a dense, silky, short pubescence only), stamen morphology (having a stronger curve between the anther body and tube on the outer surface and a narrower tube) and colour (all parts dark purple, compared with a red-purple anther body and yellow tube), and by having usually 5- or 6-merous flowers, compared with usually 4-merous flowers in *T. similis*. More subtle differences include *T. plumosa* having hairier adaxial and abaxial leaf surfaces (abaxial surface recorded as glabrous for *T. similis* in Thompson 1976), a distinctly pubescent pedicel and receptacle (both recorded as glabrous for *T. similis* in Thompson 1976) and obovate to broadly obovate, rather than ligulate to narrowly obovate, petals. Variations in these characters are discussed under *Notes*.

Dendritic hairs have also been recorded on the pedicels, receptacles and calyx segments of *T. nephelioides* R.Butcher and *T. paucifolia* Joy Thomps. (Butcher 2007a). When present, the hairs in these species are red, 0.3–1 mm long and 0.1–0.5 mm long, respectively, with a persistent glandular tip

and short, stiff, simple hairs along the shaft. *Tetratheca paucifolia* also has this hair type on the ovary (see Butcher 2007a: 142, Fig. 1F), but the shaft tends to be straight, robust and pale in colour and the glandular head more prominent. By contrast, the glandular hairs on the ovary of *T. nephelioides* are minute (<0.1 mm long) and unbranched. These species are easily distinguishable from *T. plumosa* and share with each other minute, acute tubercles on their stems and short (2.7–4.1 mm long and 1.75–4 mm long, respectively), hispid pedicels which expand gradually along their length to form the receptacle. *Tetratheca nephelioides* is further distinctive in this group in having small, scale-like, deciduous leaves and tuberculate stamens, while *T. paucifolia* has its leaves in sparse, cluster-like arrangements and stamens with the lower part of the anther flattened and contiguous with an elongate, flattened filament. *Tetratheca nephelioides* is restricted to the south of Eneabba. The range of *T. paucifolia* encompasses that of *T. plumosa*, extending from Mt Lesueur to Beverley, with three collections (*F. Hort* 1978 (PERTH); *F. Hort & J. Hort* 1983 (CANB, PERTH); *D. Rayner et al.* RG 807-15 (PERTH)) from the New Norcia–Toodyay area.

Notes. While the long, plumose ovary indumentum is highly distinctive for *T. plumosa*, the other characters distinguishing this species from *T. similis* display some variation within other species and must be used in conjunction with other characters for accurate diagnosis. For example, the stamens of *T. setigera* Endl. show considerable variation in the curvature between the anther body and tube, and those of *T. efoliata* can have either yellow or red anther tubes. Anther tube tip colour was used as a supporting feature for the recognition of subspecies in *T. paynterae* (Butcher 2007a), but has since been found to be inconsistent (P.A. Butcher pers. comm.). It must be noted, however, that all *T. similis* collections seen have yellow anther tubes.

Merosity has also been found to vary within some species with combinations of 4-, 5- and 6-merous flowers occurring on the same plant (e.g. *T. paynterae*: 4-, 5- & 6-merous flowers (Butcher 2007a); *T. exasperata* R.Butcher and *T. phoenix* R.Butcher: 5- & 6-merous flowers (Butcher 2007c); *T. pilifera*: 4- & 5-merous flowers (Thompson 1976); *T. virgata* Steetz: 4- & 5-merous flowers observed). Observation of 27 *T. plumosa* flowers from three plants found that 18 were 5-merous, seven were 6-merous and two were 7-merous, and the type material shows this variation. Some specimens of *T. similis* (e.g. *M. Hislop* 208 (PERTH); *F. Hort* 779 (PERTH), 1154 (BRI, PERTH); *F. & J. Hort* 599 (AD, CANB, NSW, PERTH 05440394)) have a small number of 5-merous flowers amongst the predominantly 4-merous ones. No 4-merous *T. plumosa* flowers have been seen, however.

Indumentum differences have been used to support the distinction of *T. plumosa* from *T. similis* (see *Affinities*); however, since Thompson's (1976) description of *T. similis* additional collections have revealed variation in the distribution and density of hairs on some parts. For example, specimens having more, and more robust, indumentum on the adaxial leaf surface than recorded by Thompson include *F. & J. Hort* 599, *F. Hort* 1153 (HO, PERTH) and *R. Davis* 4201 (PERTH). *B. Morgan* 92-1 (PERTH), *M. Hislop* 208, *M.J. Kealley* 1748 (PERTH), *F. Hort* 1153 (HO, PERTH) and *F. Hort & B. Hort* 2320 (MEL, PERTH) have simple hairs on the pedicels.

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The taxonomy of *Leucopogon bossiaea* and allied species (Ericaceae: Styphelioideae: Styphelieae) from the central south coast of Western Australia

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Abstract

Hislop, M. The taxonomy of *Leucopogon bossiaea* and allied species (Ericaceae: Styphelioideae: Styphelieae) from the central south coast of Western Australia. *Nuytsia* 19(1): 17–35 (2009). Four new species of *Leucopogon* R.Br., *L. canaliculatus* Hislop, *L. heterophyllus* Hislop, *L. remotus* Hislop and *L. rugulosus* Hislop, are described, illustrated and their distributions mapped. For purposes of comparison, a full description of their closest named relative, *L. bossiaea* (F.Muell.) Benth., is also given. A key is provided to all of the Western Australian species currently referred to the informal subgeneric group, the *Leucopogon australis* Group (*sensu* Hislop & Chapman (2007), to which the new species belong.

Introduction

In a recent paper Hislop and Chapman (2007) recognised five informal, subgeneric groups (Groups A–E) within the Western Australian members of *Leucopogon* R.Br. *s. str.*, based in large part on aspects of their fruiting morphology. The *Leucopogon australis* group (Group A) contains those species with a basically globose or ellipsoid drupe, which is usually more or less circular in section, and with a manifestly fleshy mesocarp. This essentially represents the plesiomorphic fruit type for the tribe *Styphelieae* generally, and it was recognised that in part, what unites the member species in this group is the lack of apomorphies, fruiting or otherwise. For this reason, the group is best regarded as one of convenience, until such time as a comprehensive cladistic analysis of *Leucopogon s. str.*, based on morphological and molecular data, is available.

Leucopogon bossiaea (F.Muell.) Benth. was included in Group A by Hislop and Chapman (2007), who at the same time drew attention to the presence of a subgroup of mostly unnamed taxa related to that species. The current paper provides descriptions of four new species in this subgroup (*Leucopogon canaliculatus* Hislop, *L. heterophyllus* Hislop, *L. remotus* Hislop and *L. rugulosus* Hislop) as well as, for purposes of comparison, a full description of *L. bossiaea*. A key to all member species of Group A is also presented.

Notes on the morphology and distribution of the *Leucopogon bossiaea* subgroup

Leucopogon bossiaea and the four new species described below form a discrete, closely-knit subgroup within the larger *Leucopogon australis* group. These species share a very similar floral and inflorescence morphology, a globose or slightly depressed-globose drupe and all have fire-sensitive rootstocks. Inflorescences are generally shorter and the leaves smaller than occur elsewhere in Group A (excluding the anomalous species *Leucopogon hirsutus* Sond., *L. alternifolius* R.Br. and *L. wheelerae* Hislop, which are briefly discussed in notes after the key). Two aspects of their foliar morphology are also noteworthy. Leaf petioles in all five species are relatively long and narrow, abruptly differentiated from the laminas and more or less cylindrical throughout their length. Members of the subgroup also lack the sunken venation on the adaxial surface of the lamina which characterizes most members of Group A (again excluding the anomalous species listed above and the very thick-leaved *Leucopogon validus* Hislop). Furthermore, of the five species within the subgroup, four have a locule number of three or four, only *L. canaliculatus* having the four- or five-locular ovary which is the common number for Group A as a whole.

Corroborating evidence that the species treated in this paper comprise a natural grouping is provided by the common occurrence on all species of a distinctive decurved bud gall (Figure 1A). Examination of these galls by entomologists Dr T. Houston and Dr J. La Salle (Western Australian Museum and CSIRO Entomology respectively) has not yielded positive results as to the identity of the gall-formers, although members of the Hymenoptera or Hemiptera are thought to be the most likely causative agents. The galls are so prevalent among species from the subgroup that almost all populations observed by the author were affected, and they are present on a high percentage of herbarium collections. This type of bud gall has not been observed on any other species assigned to Group A. A similar decurved

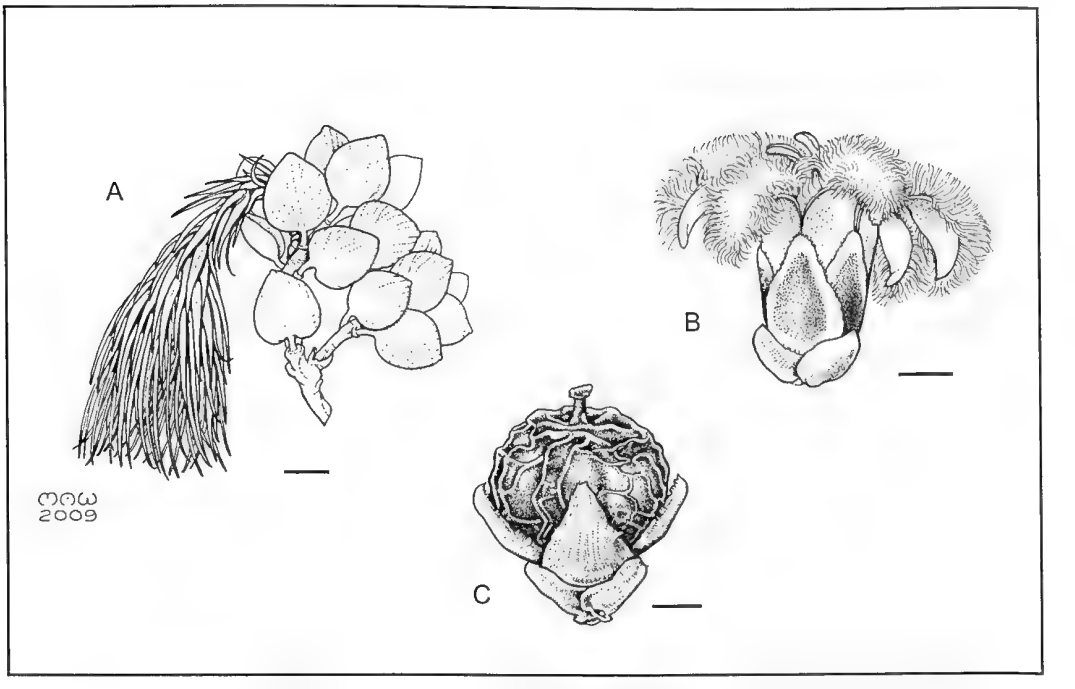

Figure 1. A – Bud gall on *Leucopogon bossiaea*. B.– C. *Leucopogon heterophyllus*. B – flower; C – fruit. Scale bars: A = 2 mm; B, C = 1 mm. Drawn by Margaret Wilson from *M. Hislop* 3758 (A), *M. Hislop* 3711 (B), *M. Hislop* 3739 (C).

gall is associated with the members of Group B, but these differ in having hairy surfaces and recurved rather than straight 'scales'.

Whereas differences in floral and fruiting characters within the *Leucopogon bossiaea* subgroup are subtle, there is a manifest dichotomy in foliar morphology, such that a close relationship between the two elements may not be self evident. On the one hand are those species with more or less flat, openly grooved and glabrous leaves, and on the other those with revolute margins, partially or wholly concealing the tightly grooved and hairy abaxial surfaces. *Leucopogon heterophyllus* and *L. canaliculatus* are representative of the flat and revolute elements respectively and could be regarded as the most dissimilar species in the subgroup. The differences between them are maintained across most of their respective geographic ranges. However in the Cascades area (which falls at the eastern edge of the range of *L. heterophyllus* and at the western edge of *L. canaliculatus*) three rather problematic populations occur. These somewhat blur the boundaries between the two species and also between *L. canaliculatus* and *L. rugulosus*. These populations are discussed below in the treatments of *L. canaliculatus* and *L. heterophyllus*.

The five members of the *Leucopogon bossiaea* subgroup are distributed between the Ravensthorpe area and Israelite Bay, always within about a hundred kilometres of the south coast. Three of these, *Leucopogon bossiaea*, *L. remotus* and *L. rugulosus*, appear to be local endemics, while the other two, *L. heterophyllus* and *L. canaliculatus*, have a wider regional distribution, although neither could be considered widespread.

Methods

This study was based on an examination of dried specimens housed at PERTH and NSW. All species in the *Leucopogon bossiaea* subgroup have been seen by the author in the field, usually at several localities, and plant growth habit and proportions given in the descriptions are based on these field observations.

Foliar measurements were taken from dried specimens. Leaf thickness was measured at the midrib, half way along the lamina. Observations of leaf venation were made from mature leaves only. Across the tribe *Styphelieae* generally it is common for young leaves to show prominently raised venation on the abaxial surface which is much less evident, if at all, at maturity. Similarly, the first leaves produced at the beginning of a flush of vegetative growth should be ignored. The lowest of these are bract-like, but then there is a morphological transition at successive nodes before the form of the mature leaves is reached.

Inflorescence length was measured from its insertion point in a leaf axil (this may be somewhat obscured by several rows of sterile bracts) to the tip of the bud rudiment. Floral measurements were taken from re-hydrated flowers in natural posture, with the exception of the corolla lobes. These were uncurled to their fullest length before measuring. Anthers were measured around the bend rather than in a straight line between the furthest points. The length of the sterile tips was measured in late bud or early flower, at or just prior to, anther dehiscence. Corolla lobe hair length was measured at a point 0.5 mm below the lobe apex. Where sufficient material was available, at least ten flowers per specimen were examined.

The distribution map was compiled using DIVA-GIS Version 5.2.0.2 and based on PERTH specimen data.

A synopsis of and key to the *Leucopogon australis* group in Western Australia

Rootstock fire-tolerant or fire-sensitive; leaves spirally arranged or in pseudo-whorls, variably antrorse or occasionally ± patent; upper leaves and lower fertile bracts usually clearly dimorphic; inner surfaces of corolla tube glabrous, or if apparently hairy, these hairs reflexed into the tube from the base of the corolla lobes or from a narrow ring of hairs at the tube apex; abaxial surface of corolla lobes glabrous; ovary glabrous, usually 4 or 5-locular, less often 2 or 3-locular; nectary annular; drupes depressed-obovoid, depressed-globose, globose, ellipsoid or ovoid, usually ± circular in transverse section, but transversely elliptic or trigonous in *L. alternifolius* and *L. wheelerae*, with a significant mesocarp layer present, the apex smoothly rounded at the shoulders; endocarp woody.

1. Longest leaves in pseudo-whorls
  2. Longest leaves < 40 mm long; corolla white, hairs uniformly distributed on corolla lobes (Cape Le Grand – Cape Arid – Recherche Archipelago) ..... **L. interruptus**
  2: Longest leaves > 50 mm long; corolla pink, hairs restricted to lower half of corolla lobes (wetter parts of the south-west, Perth–Augusta–just E of Albany) ..... **L. verticillatus**
1: Longest leaves not in pseudo-whorls
  3. Longest leaves > 30 mm long
    4. Inflorescence ± pendulous, axis glabrous (restricted distribution E of Albany) ..... **L. altissimus**
    4: Inflorescence erect, axis hairy
      5. Young branchlets entirely glabrous; leaf margins entirely glabrous
        6. Leaves narrowly ovate to narrowly elliptic (length to width ratio of longest leaves 6.1–11.2 : 1); fruit depressed globose (plants of forest and winter-wet heath in wetter parts of the south-west, Gingin–Augusta–Albany) ..... **L. australis**
        6: Leaves narrowly obovate to narrowly elliptic (length to width ratio of longest leaves 2.8–6.2: 1); fruit globose, ovoid or broadly ellipsoid (plants of coastal heath along the west and south coasts between Dongara and Israelite Bay) ..... **L. parviflorus**
      5: Young branchlets minutely hairy throughout, or at least around the nodes; leaf margins scabrous with minute, stiff, antrorse hairs
        7. Length to width ratio of longest leaves 7.2–13.9 : 1; widest leaves 2.5–5.0 mm wide, marginal hairs present along entire leaf length on most leaves (plants of forest and mountain heath, Augusta–Bridgetown–Albany–Stirling Range) ..... **L. interstans**
        7: Length to width ratio of longest leaves 2.8–6.2 : 1; widest leaves 4–9 mm wide, marginal hairs, if present, confined to upper half (plants of coastal heath along the west and south coasts between Dongara and Israelite Bay) ..... **L. parviflorus**
  3: Longest leaves < 30 mm long
    8. All leaves with manifestly recurved or revolute margins, often partially concealing the lower surface.
      9. Longest leaves 3 mm long or less; length to width ratio of longest leaves 1.4–3.1 : 1; ovary usually 3-locular, rarely 4-locular (restricted distribution NW of Esperance) ..... **L. rugulosus**
      9: Longest leaves at least 5 mm long; length to width ratio of longest leaves usually >5: 1; ovary 5-, 4- or 2-locular, very rarely 3-locular
        10. Both leaf surfaces with short, patent hairs; sepals acute or subacute; ovary 2- or very occasionally 3-locular (Moresby Range) ..... **L. borealis**
        10: Upper leaf surface usually glabrous or with short, tubercle-based, antrorse hairs; sepals obtuse or occasionally subacute; ovary 5- or 4- locular, very occasionally 3-locular
          11. Abaxial leaf surface deeply grooved between prominent ribs, patent-hairy in the grooves, adaxial leaf surface without evident venation, usually glabrous but if somewhat hairy, then hairs variously orientated, not tubercle-based (N and NE of Esperance) ..... **L. canaliculatus**

11: Abaxial leaf surface smooth or faintly striate, glabrous, or with a sparse, evenly distributed indumentum, adaxial leaf surface with 1 or 3 sunken veins evident, always scabrous with antrorse, tubercle-based hairs

12. Leaf apex obtuse or rather abruptly contracted to a blunt point, leaf margins apparently glabrous (minutely ciliolate under high magnification) (forest and coastal heath between Augusta and Cape Arid) ..... **L. obovatus**

12: Leaf apex smoothly attenuate, leaf margins manifestly ciliolate with hairs 0.05–0.20 mm long (Perth–Augusta–Bridgetown–Albany)..... **L. capitellatus**

8: Leaves adaxially concave, flat or if margins somewhat recurved, then these not concealing the abaxial surface

13. Longest leaves < 10 mm long (very occasional specimens of *L. capitellatus* may have their longest leaves less than 10 mm)

14. Leaf bases deeply cordate, ± stem clasping, petiole very indistinct. Inflorescence axis glabrous or occasionally very sparsely hairy. Fruit trigonous or transversely elliptic in cross section

15. Sepals 1.0–1.5 mm long; corolla tube shallowly campanulate, 0.5–0.8 mm long, corolla lobes 1.0–1.4 mm long, sparsely bearded; anthers 0.4–0.7 mm long; fruit 0.9–1.2 mm long and 0.7–1 mm wide (swamps between Augusta and the Donnelly River) ..... • **L. alternifolius**

15: Sepals 1.5–2.1 mm long; corolla tube campanulate, 1.3–1.8 mm long, corolla lobes 1.7–2.1 mm long, densely bearded; anthers 1.2–1.6 mm long; fruit 1.8–2.1 mm long and 1.1–1.5 mm wide (swamps between Walpole & Albany) ..... • **L. wheelerae**

14: Leaf bases cordate or not, but if so then leaves with well defined petioles; inflorescence axis always manifestly hairy; fruit circular in cross section

16. Leaf surfaces and margins hairy with a mixed indumentum (hairs forming two or sometimes three ± distinct layers), the longest hairs of which are > 0.4 mm long; corolla lobes with sparse hairs confined to upper half (swamps between Cape Naturaliste and Albany with an outlier near Collie). ..... • **L. hirsutus**

16: Leaf surfaces glabrous, margins minutely ciliolate; corolla lobes densely bearded throughout

17. Leaves narrowly ovate, ovate, narrowly elliptic or elliptic, length to width ratio of longest leaves 2.6–3.9: 1, lamina usually concave, less often flat, never convex, markedly incurved along longitudinal axis, apex acute, straight, base cuneate (restricted distribution NE of Esperance) ..... **L. remotus**

17: Leaves depressed-ovate, broadly ovate, ± circular or elliptic, length to width ratio of longest leaves 0.8–2.5: 1, lamina concave, flat or convex, longitudinal axis ± straight, apex obtuse or subacute, usually slightly deflexed, base cuneate, rounded, truncate or cordate

18. Sepals 1.9–2.6 mm long, 1.1–1.6 mm wide; corolla tube 1.3–2.0 mm long, corolla lobes 1.9–3.5 mm long, corolla lobe to tube ratio 1.4–2: 1; style 0.6–0.9 mm long; ovary 0.6–0.7 mm long , 0.6-0.8 mm wide (Ravensthorpe to the Cascades area) ..... **L. heterophyllus**

18: Sepals 1.4–1.9 mm long, 0.8–1.2 mm wide; corolla tube 1.1–1.5 mm long, corolla lobes 1.5–2.0 mm long, corolla lobe to tube ratio 1.1–1.4 : 1; style 0.4–0.5 mm long; ovary 0.5–0.6 mm long, 0.5–0.6 mm wide (restricted distribution in the Israelite Bay area) ..... **L. bossiaea**

13: Longest leaves > 10 mm long

19. Sepals 2.4 mm or longer, acute or subacute; corolla lobes 2.8–4.4 (usually > 3) mm long

20. Longest fertile bracts in any inflorescence at least 2 mm long; style (including stigma) 2.0–3.0 mm long (Cape Le Grand – Cape Arid – Recherche Archipelago–Russell Range)..... **L. apiculatus**

20: Longest fertile bracts in any inflorescence *c.* 1.5 mm long; style 0.5–1.0 mm long.

21. Leaves 15–25 mm long; inflorescence axis 20–65 mm long; bracteoles 1.1–1.6 mm long; flowers clearly pedicellate below the bracteoles (Helena and Aurora Range) ..... **L. spectabilis**

21: Leaves 9–16 mm long; inflorescence axis 5–15 mm long; bracteoles 1.8–2.2 mm long; flowers sessile (Parker Range) ..... **L. validus**

19: Sepals to 2.2 mm long, obtuse (acute or subacute in *L. interstans*); corolla lobes 1.7–3.0 (usually < 2.8) mm long

22. Branchlet indumentum dense, patent or antrorse, dimorphic, the longer hairs 0.3–0.7 mm long; upper leaf surface always scabrous with antrorse, tubercle-based hairs (Perth–Augusta–Bridgetown–Albany) ..... **L. capitellatus**

22: Branchlets glabrous, or if hairy, then indumentum monomorphic and usually sparse, < 0.1 mm long; upper leaf surface glabrous, except sometimes immediately above the petiole

23. Length to width ratio of longest leaves 7.2–13.9 : 1, widest leaves 2.5–5.0 mm wide, marginal hairs present along entire leaf length on most leaves (plants of forest and mountain heath, Augusta–Bridgetown–Albany–Stirling Range) ..... **L. interstans**

23: Length to width ratio of longest leaves 2.8–6.2 : 1, widest leaves 4–9 mm wide, marginal hairs, if present, confined to upper half (plants of coastal heath along the west and south coasts between Dongara and Israelite Bay) ..... **L. parviflorus**

Those species with the prefix • in the key are somewhat tentatively placed within Group A. Although *Leucopogon alternifolius* R.Br. and its close relative *Leucopogon wheelerae* Hislop have the fleshy mesocarp and inflorescence character in common with the other members of Group A, the drupe is either trigonous or transversely elliptic in cross section (i.e. compressed laterally), depending on whether two or three fruiting locules develop. This feature is not found elsewhere in the group. The other 2-locular species, *L. borealis* Hislop & A.R. Chapm. and *L. hirsutus* Sond. have a drupe which is either circular in cross section or very slightly compressed at maturity. The usually glabrous, prominently flexuose inflorescence axis and deeply cordate, often longitudinally folded, leaves of *Leucopogon alternifolius* and *L. wheelerae* are also unusual.

Leucopogon hirsutus has an anomalous corolla hair distribution. Instead of the typically dense indumentum characteristic of the genus, the lobes are largely glabrous apart from a zone of very sparse hairs close to the apex. The drupe of *L. hirsutus* is unique among western members of *Leucopogon s. str.* in that the suture line on the surface of the endocarp is recessed within a groove in a prominently raised broad rib. The rib itself represents the lignified margins of the two narrow, vertically compressed locules which are positioned end to end. These are significantly narrower than the very thick endocarp walls on either side of the rib. The flowers of *L. hirsutus* and *L. alternifolius* are the smallest of all of the western species of *Leucopogon s.str.*

Taxonomy

Leucopogon bossiaea (F.Muell.) Benth. *Fl. Austral.* 4: 190 (1868).– *Styphelia bossiaea* F.Muell., *Fragm.* 6: 47 (1867). *Type*: In rupibus graniticis ad sinum Great Bight, *G. Maxwell s.n.* (*holo*: MEL 75727, scanned image seen; *iso*: PERTH 07480539!; K 000348425, scanned image seen).

Erect *shrubs* to *c.* 100 cm high and 80 cm wide, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* light brown, smooth, glabrous or with a sparse indumentum of very short patent hairs < 0.1 mm long, but at length glabrescent; the bark on older stems ± fissured, grey over

brown. *Leaves* spirally arranged, antrorse, usually steeply so, elliptic, ovate, broadly ovate, or almost circular, 2.6–4.1 mm long, 2.1–3.9 mm wide; apex obtuse with a barely differentiated callus point; base rounded, truncate or occasionally shallowly cordate; petiole well defined, pale greenish-yellow, 0.5–1.0 mm long, glabrous throughout; lamina 0.3–0.4 mm thick, slightly concave adaxially, ± flat or slightly convex, ± straight along longitudinal axis; surfaces discolorous, glabrous, adaxial surface slightly shiny, venation not evident, abaxial surface paler with 5–7 primary veins, which vary from only slightly to quite prominently raised, the midrib not differentiated; margins glabrous or coarsely ciliolate with antrorse hairs. *Inflorescence* erect, terminal and upper-axillary; axis 3–10 mm long, with 4–11 flowers, terminating in a bud-like rudiment; indumentum of sparse to moderately dense, patent hairs < 0.05 mm long; flowers erect and sessile. *Fertile bracts* broadly ovate to depressed-ovate, 0.5–0.6 mm long, 0.5–0.7 mm wide, obtuse; abaxial surface with obscure venation, glabrous; adaxial surface glabrous, or with short, appressed hairs towards apex; margins minutely ciliolate. *Bracteoles* broadly ovate to almost circular, 0.8–1.0 mm long, 0.8–1.0 mm wide, obtuse, keeled; abaxial surface glabrous, the central portion greenish-grey and often tinged purple along the upper keel, becoming scarious towards margins; adaxial surface glabrous or shortly antrorse-hairy; margins ciliolate. *Sepals* ovate, 1.4–1.9 mm long, 0.8–1.2 mm wide, obtuse; abaxial surface glabrous, greenish or greenish-grey in the central portion but often tinged purple towards the apex and edges, becoming scarious towards margins, the venation inconspicuous; adaxial surface with a sparse indumentum of antrorse hairs in distal half; the margins minutely ciliolate with hairs < 0.05 mm long. *Corolla tube* white, broadly campanulate, usually slightly longer than (by up to 0.4 mm), or about the same length as the sepals, 1.1–1.5 mm long, 1.2–1.5 mm wide, glabrous externally and internally. *Corolla lobes* white, sometimes partly tinged pink, slightly longer than the tube (ratio = 1.0–1.4:1), widely spreading from base and recurved, 1.5–2.0 mm long, 0.9–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.4–0.6 mm long near apex, glabrous tip 0.1–0.2 mm long. *Anthers* partially exserted from tube (by 3/4–7/8 of length) in early flower, but often becoming fully exserted and held at right angles to the floral axis, 0.9–1.3 mm long, recurved at apex; sterile tips inconspicuous, 0.25–0.35 mm long; *filaments* terete, attached 2/3–3/4 above anther base, 0.4–0.5 mm long, adnate to tube just below sinus. *Ovary* globose, 0.5–0.6 mm long, 0.5–0.6 mm wide, glabrous, usually 3-, less often 4-locular; *style* 0.4–0.5 mm long, tapering smoothly from the base, included within the corolla tube; *stigma* slightly expanded; *nectary* annular, 0.25–0.35 mm long, lobed for 1/3–1/2 of length, glabrous. *Fruit* globose, with smoothly rounded shoulders, glabrous, 1.4–1.6 mm long, 1.3–1.5 mm wide, longer than the calyx, the surface with prominent transverse and longitudinal ridges; style persistent.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Apr. 1993, *G.F. Craig* 2562 (NSW, PERTH); 18 May 2002, *M. Hislop & F. Hort* MH 2620 (PERTH); 19 May 2002, *M. Hislop & F. Hort* MH 2632 (PERTH); 24 Apr. 2008, *M. Hislop* 3758 (CANB, K, NSW,PERTH); 29 July 1986, *J.M. Powell* 2200 (HO, NSW); 2200A (NSW); 2200B (K, L, NSW, NY); 2200C (NSW); June 1948, *D.L. Serventy s.n.* (PERTH).

Distribution and habitat. Currently known only from the Israelite Bay area east of Esperance (Figure 2), where it grows in sandy or sandy-loam soils in open mallee woodland or heath.

Conservation status. On the basis of current knowledge *Leucopogon bossiaea* appears to have a very restricted distribution. Although the known populations are conserved within Nuytsland Nature Reserve, a potential threat could be posed by the continued spread in that area of the serious perennial weed Bridal Creeper – *Asparagus asparagoides* (L.) W.F.Wight. Recently listed as Priority Two under the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora.

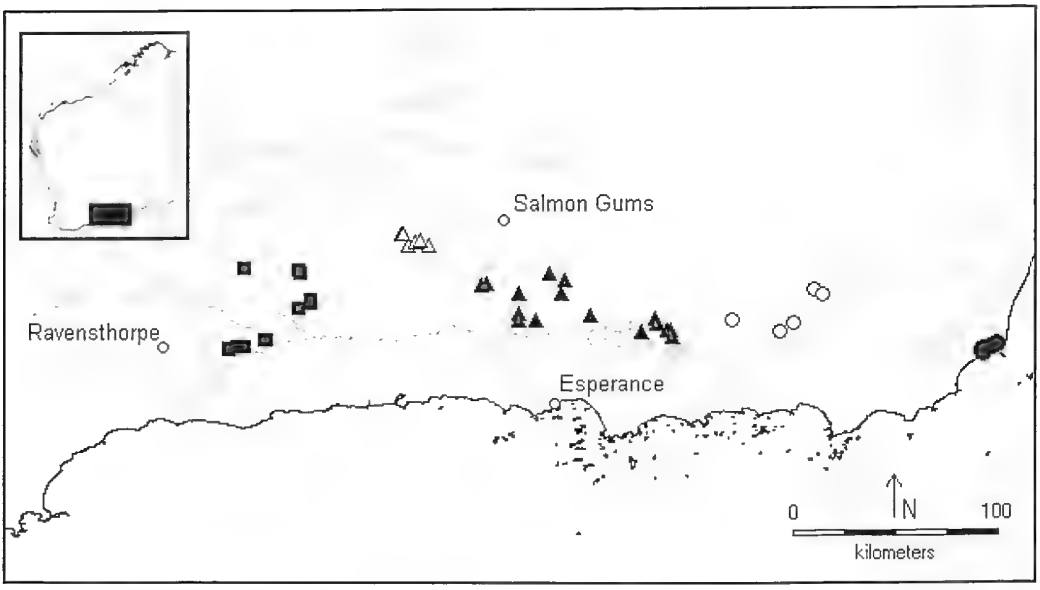

Figure 2. Distribution of *Leucopogon bossiaea* (●), *L.canaliculatus* (▲), *L. heterophyllus* (■), *L. remotus* (○), and *L. rugulosus* (△) in Western Australia.

Notes. Although Israelite Bay is situated at the eastern extremity of the South-West Botanical Province it has a surprisingly rich epacrid flora. At least twenty species are known to occur within a ten kilometre radius of the bay, most of these belonging in the tribe *Styphelieae*. *Leucopogon bossiaea* is one of two epacrids which, on the basis of current knowledge, are restricted to this area. The other is a member of *Leucopogon* s. lat. and is known by the phrase name *Leucopogon* sp. Israelite Bay (C.F. Craig 2558).

Leucopogon canaliculatus Hislop, *sp. nov.*

Leucopogi obovato (Labill.) R.Br. affinis sed foliis manifeste petiolatis paginis abaxialibus profunde exaratis differt.

Typus: Corner Griggs and Esperance – Norseman Rd, N of Scaddan, Western Australia, 17 May 2002, *M. Hislop & F. Hort* MH 2611 (*holo*: PERTH 06115128; *iso*: CANB, K, NSW).

Leucopogon sp. Scaddan (M. Hislop & F. Hort MH 2611), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed January 2009].

Erect, usually rather compact *shrubs* to *c.* 120 cm high and 100 cm wide, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* light brown, smooth, glabrous or with an irregular, sparse indumentum of patent hairs and then soon glabrescent; older stems with dark grey, ± fissured bark. *Leaves* spirally arranged, antrorse, usually steeply so, linear, 5–13 mm long, 0.9–1.6 mm wide; apex acute with an innocuous, straight or slightly recurved mucro to 0.5 mm long; base cuneate; petiole well defined, yellowish-green or pale brown, 0.7–1.3 mm long, glabrous throughout or sparsely hairy on adaxial surface; lamina 0.3–0.4 mm thick, usually revolute at maturity with the abaxial surface often ± concealed; surfaces discolorous, adaxial surface shiny, glabrous or sparsely

and shortly antrorse-hairy, venation not evident, abaxial surface paler with 5–7 prominent, primary veins and deep furrows between, the midrib not or barely differentiated, densely hairy in the furrows, ± glabrous on the exposed surface of the veins; margins usually coarsely ciliolate in the upper half with rather sparse patent to antrorse hairs. *Inflorescence* erect, mostly terminal with usually limited upper-axillary development; axis (7–)9–18 mm long, with 7–17 flowers terminating in a bud-like rudiment; indumentum of moderately dense, short, patent hairs to 0.05 mm long; flowers erect and sessile. *Fertile bracts* ovate, at least the lower ones with a cordate base, 1.1–1.7 mm long, 1.0–1.3 mm wide, obtuse; abaxial surface with inconspicuous or moderately conspicuous venation, glabrous or sparsely and very shortly hairy on central portion; adaxial surface appressed-hairy on upper bracts, ± glabrous on lower; margins ciliolate. *Bracteoles* ovate, 1.2–1.6 mm long, 1.0–1.2 mm wide, obtuse or subacute, sharply keeled; abaxial surface with short, moderately dense, patent hairs along the keel, glabrous or very sparsely hairy elsewhere, the keel and upper central portion suffused dull purple, pale greenish elsewhere, then becoming scarious towards the margins; adaxial surface antrorse-hairy in distal half; margins ciliolate. *Sepals* ovate, 1.9–2.5 mm long, 1.2–1.5 mm wide, obtuse or occasionally subacute; abaxial surface varying from almost glabrous to shortly antrorse-hairy in distal half, pale greenish in basal half, usually suffused dull purple distally, the venation inconspicuous; adaxial surface antrorse-hairy in distal half; the margins ciliolate with hairs to *c.* 0.1 mm long and broadly scarious. *Corolla tube* white, broadly campanulate, about as long as, very slightly shorter than or very slightly longer than sepals, 1.3–1.9 mm long, 1.3–2.0 mm wide, glabrous externally and internally. *Corolla lobes* white, sometimes flushed pink towards apex, longer than the tube (ratio = 1.1–1.7: 1), widely spreading from base and recurved, 1.7–2.6 mm long, 0.8–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.5–0.7 mm long near apex, the basal hairs reflexed into the top of the tube by up to 0.8 mm but usually less, the glabrous tip 0.2–0.3 mm long. *Anthers* partially exserted from tube (by 2/3–3/4 of length) in the early stages of flowering but later may be fully exserted and held at right angles to the floral axis, 1.0–1.3 mm long, slightly recurved at apex; sterile tips inconspicuous, 0.2–0.3 mm long; *filaments* terete, attached 2/3–3/4 above anther base, 0.4–0.7 mm long, adnate to tube just below sinus. *Ovary* depressed-globose or globose, 0.5–0.7 mm long, 0.6–0.8 mm wide, glabrous, 4- or 5-locular; *style* 0.7–0.8 mm long, smoothly tapering from a broad base to the stigma, included within corolla tube; *stigma* not or very slightly expanded; *nectary* annular, 0.2–0.5 mm long, shallowly lobed for up to 1/3 of length, glabrous. *Fruit* depressed-globose, with smoothly rounded shoulders, glabrous, 1.3–1.8 mm long, 2.3–2.6 mm wide, slightly longer than the calyx, the surface with prominent transverse and longitudinal ridges; style persistent.(Figure 3A–C).

Other specimens examined. WESTERN AUSTRALIA: 11.5 km S of Grass Patch Tavern along Coolgardie Esperance Highway, 1 km S of Rhinds Rd, W side of highway, 20 July 2001, *B. Archer* 1933 (MEL, PERTH); 5 km SE of Kau Rock, on Kau Rocks Rd, Reserve no. 32776, 29 Mar. 1983, *M.A. Burgman & S. McNee* MAB 1125 (PERTH); 4 km E of Scaddan, 4 Oct. 1995, *R.J. Cranfield* 10449 (PERTH); 5.6 km W along Kau Rock Rd from junction of Coolinup Rd, *c.* 23 km NW of Condinup, 26 May 2005, *R. Davis* 10880 (NSW, PERTH); 55 km NE of Scaddan, 100 m W along track 2.8 km S along Styles Rd from junction of Ridley Rd, 18 June 2006, *R. Davis* 11001 (CANB, PERTH); 36 km NE of Scaddan, 7.4 km E along Lignite Rd from junction with Truslove Rd, 20 June 2006, *R. Davis* 11015 (PERTH); 15 km SE of Mt Burdett, 500 m along Mt Ney Rd from junction of Burdett Rd, 26 June 2006, *R. Davis* 11059 (PERTH); 14 km SW of Mt Ney, 9 km N along Mt Ney Rd from junction of Burdett Rd, 26 June 2006, *R. Davis* 11064 (PERTH); *c.* 5 m from shoreline at S end of salt lake, 16 km E of Grass Patch via Starcevich & Ridley Rds, 21 May 2004, *M. Hislop & F. Hort* MH 3213 (CANB, NSW, PERTH); Norwood Rd 2.4 km E of Dempster Rd, E of Scaddan, 22 May 2004, *M. Hislop & F. Hort* MH 3221 (PERTH); 1.2 km SSE of Mt. Ney Rd on Kau Rock Rd, 20 Sep. 1985, *L. Nunn* 168 (CANB, PERTH); Drainage line *c.* 1 km S of Rasyk Rd on E boundary of Loc. 447, 28 Sep. 1998, *T. Stone & L. Cambell s.n.* (PERTH).

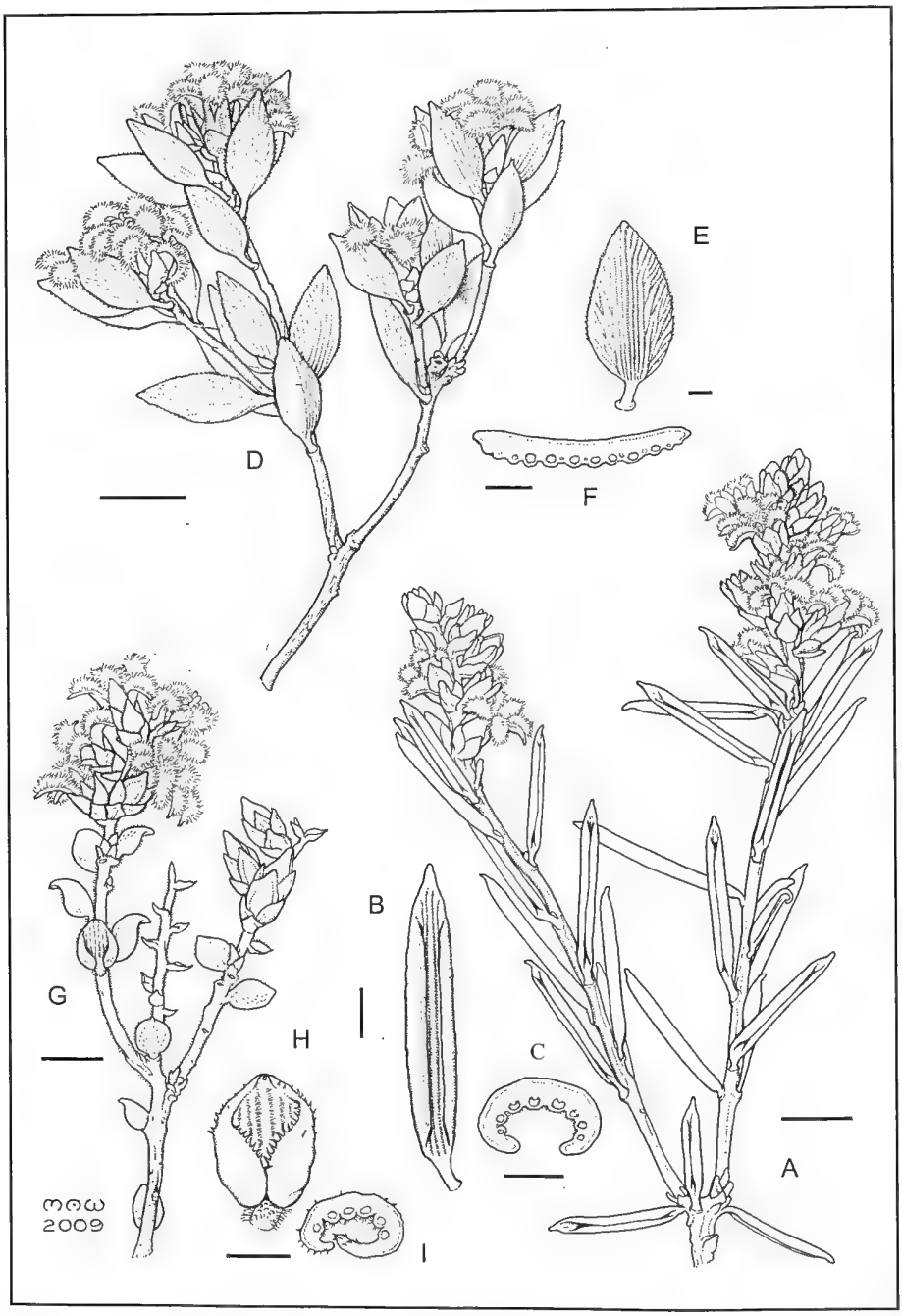

Figure 3. A – C. *Leucopogon canaliculatus*. A – flowering branchlet; B – leaf, abaxial surface; C – leaf section. D – F. *Leucopogon remotus*. D – flowering branchlet; E – leaf, abaxial surface; F – leaf section; G – I. *Leucopogon rugulosus*. G – flowering branchlet; H – leaf, abaxial surface; I – leaf section. Scale bars: A = 5 mm; B, E, H, I= 1 mm; C, F = 0.5 mm; D = 5 mm; G = 3 mm; . Drawn by Margaret Wilson from *M. Hislop* 3221 (A, B, C), *M. Hislop* 3629 (D, E, F), *W. O'Sullivan* 960 (G, H, I).

Distribution and habitat. Known from a rather narrow east – west band in the north of the Esperance region, extending from a little west of Grass Patch at least as far east as the Kau Rock Nature Reserve north of Condingup (Figure 2). The plant grows in mallee woodland or heathland communities generally in low-lying, sometimes subsaline habitats, usually over sandy loam soils but often with clay at depth.

Phenology. Flowers have been recorded from March through to July and mature fruit in September and October.

Etymology. The epithet derives from the Latin *canaliculatus* (channelled), and refers to the characteristic abaxial groove or channel produced between the abutting margins of the mature, revolute leaves.

Conservation status. The new species is locally common across its known range. Although currently recorded from only two nature reserves, based on an assessment of the local geography, it seems likely that it will be present in several others within the region. To the north and north-east of its known occurrence are large, inaccessible tracts of uncleared crown land, which includes similar low-lying country. The species is also likely to occur in this area, at least in the south. In the absence of any discernible threatening processes no conservation coding is recommended here.

Affinities. *Leucopogon canaliculatus* is superficially similar to, and has been confused with, *L. revolutus*, from which it can be readily separated by leaf characteristics. The upper leaf surfaces of the new species are glabrous or sparsely and irregularly hairy with no venation evident. The lower surfaces have deep, hairy furrows between prominently raised veins. By contrast, *L. revolutus* has the upper surfaces always scabrous with antrorse, tubercle-based hairs and one or three rather conspicuous sunken veins. The lower surfaces are more or less smooth or slightly striate and either glabrous or sparsely hairy throughout.

The closest relative of *L. canaliculatus* is the narrowly distributed *L. rugulosus*, described below. Both have revolute leaves which are hairy and deeply grooved abaxially, but in the case of the latter the leaves and inflorescences are shorter and the ovary is 3 (rarely 4)-locular, rather than 5- or 4-locular. Additionally the sepals of *L. rugulosus* are more acute, the abaxial leaf surface hairy throughout (rather than just in the grooves), the petiole shorter and always hairy throughout, and the fruit apparently narrower.

Although the two species are generally quite distinct and easily separated, two anomalous populations are known in the west of the range of *L. canaliculatus* (represented by the collections *M. Hislop* 3623 and *M. Hislop* 3708) which erode somewhat the distinctions between the two. These specimens have shorter than normal leaves (as short as 4 mm, though this is still longer than recorded for *L. rugulosus*) and inflorescence axes and frequently have 3- as well as 4-locular ovaries. This locule number was not recorded for any other collections of *L. canaliculatus* (despite comprehensive sampling – refer note under methods) but a 3-locular ovary is the norm for *L. rugulosus*. However in respect to the other separating characters between the two species, described above, both collections are quite typical of *L. canaliculatus*.

There is also a strong similarity in foliar morphology between plants from the two populations cited above and those from a population (represented by *Hislop* 3712) described below in the notes section under *L. heterophyllus*. Only the complete absence of hairs in the abaxial leaf grooves, separate the latter population from the two described above.

Leucopogon heterophyllus Hislop, *sp. nov.*

Leucopogi bossiaea (F. Muell.) Benth. affinis a qua imprimis differt sepalis grandioribus, corolla grandiore, et stylo longiore.

Typus: unmanaged Reserve No 29713, West Point Rd, 12 km N of South Coast Highway, NW of Munglinup, 27 June 2007, *M. Hislop* 3713 (*holo*: PERTH 07615302; *iso*: CANB, K, MEL,NSW).

Erect *shrubs* to 150 cm high and 120 cm wide, but usually smaller, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* light brown, glabrous, or with a very short, irregular indumentum of patent hairs; the bark on older stems grey, fissured and often somewhat stringy. *Leaves* spirally arranged, antrorse, usually steeply so, varying from depressed-ovate, broadly ovate, deltoid or ± circular to ovate, elliptic or rarely obovate, 2.0–6.4 mm long, 1.9–4.7 mm wide; apex obtuse or subacute, with a rather indistinct callus point; base cuneate, rounded, truncate or cordate; petiole well defined, pale greenish-yellow to yellowish-brown, 0.6–1.3 mm long, glabrous throughout; lamina 0.25–0.40 mm thick, concave adaxially, flat, convex or with manifestly recurved margins; surfaces discolorous, glabrous, adaxial surface shiny, venation not evident, abaxial surface paler with 5–7 ± raised primary veins, the midrib not differentiated; margins glabrous or coarsely ciliolate with antrorse hairs. *Inflorescence* erect, terminal and upper-axillary; axis 3–10 mm long, with 3–10 flowers, terminating in a bud-like rudiment; indumentum of sparse, patent hairs <0.05 mm long; flowers erect and sessile. *Fertile bracts* broadly ovate or ovate, 0.5–0.8 mm long, 0.6–0.8 mm wide, obtuse; abaxial surface with venation very obscure, glabrous; adaxial surface with short, appressed hairs towards apex; margins minutely ciliolate. *Bracteoles* broadly ovate, 0.9–1.5 mm long, 0.8–1.3 mm wide, obtuse, keeled; abaxial surface glabrous, or with a very few short hairs about the upper keel, the central portion greenish, usually suffused purple along the upper keel and in a submarginal band, becoming paler and scarious towards the margins; adaxial surface shortly antrorse-hairy; the margins minutely ciliolate. *Sepals* ovate, (1.7–)1.9–2.6 mm long, 1.1–1.6 mm wide, obtuse; abaxial surface glabrous, the central portion greenish or greyish-green, ± suffused purple towards apex and in a submarginal band which is well differentiated from the paler, scarious marginal band, the venation inconspicuous; adaxial surface with a sparse indumentum of antrorse-appressed hairs in distal half; the margins minutely ciliolate with hairs <0.05 mm long. *Corolla tube* white, broadly campanulate, about as long as, slightly longer than or slightly shorter than sepals (by up to 0.3 mm), 1.3–2.0 mm long, 1.5–2.0 mm wide, glabrous externally and internally apart from a few hairs below the base of the lobes. *Corolla lobes* white, sometimes wholly or in part tinged pink, much longer than the tube (ratio = 1.4–2: 1), widely spreading from the base and recurved, 1.9–3.5 mm long, 0.8–1.0 mm wide at the base, glabrous externally, densely bearded internally, indumentum white, 0.6–0.8 mm long near apex, the glabrous tip 0.1–0.2 mm long. *Anthers* partially exserted from tube (by 3/4–7/8 of length) in early flower, but often becoming fully exserted and held at right angles to the floral axis, 1.0–1.8 mm long, recurved at apex; sterile tips inconspicuous, 0.3–0.4 mm long; *filaments* terete, attached 2/3–3/4 above anther base, 0.6–0.9 mm long, adnate to tube just below sinus. *Ovary* globose or depressed-globose, 0.6–0.7 mm long, 0.6–0.8 mm wide, glabrous, 3- or 4-locular; *style* 0.6–0.9 mm long, tapering smoothly from the base, included within the corolla tube; *stigma* slightly to distinctly expanded; *nectary* annular, 0.3–0.5 mm long, entire or lobed for up to 1/3 of length, glabrous. *Fruit* globose or depressed-globose, with smoothly rounded shoulders, 1.7–2.1 mm long, 1.8–2.3 mm wide, longer than calyx, the surface with a reticulum of transverse and longitudinal ridges; style persistent. (Figures 1B–C, 4)

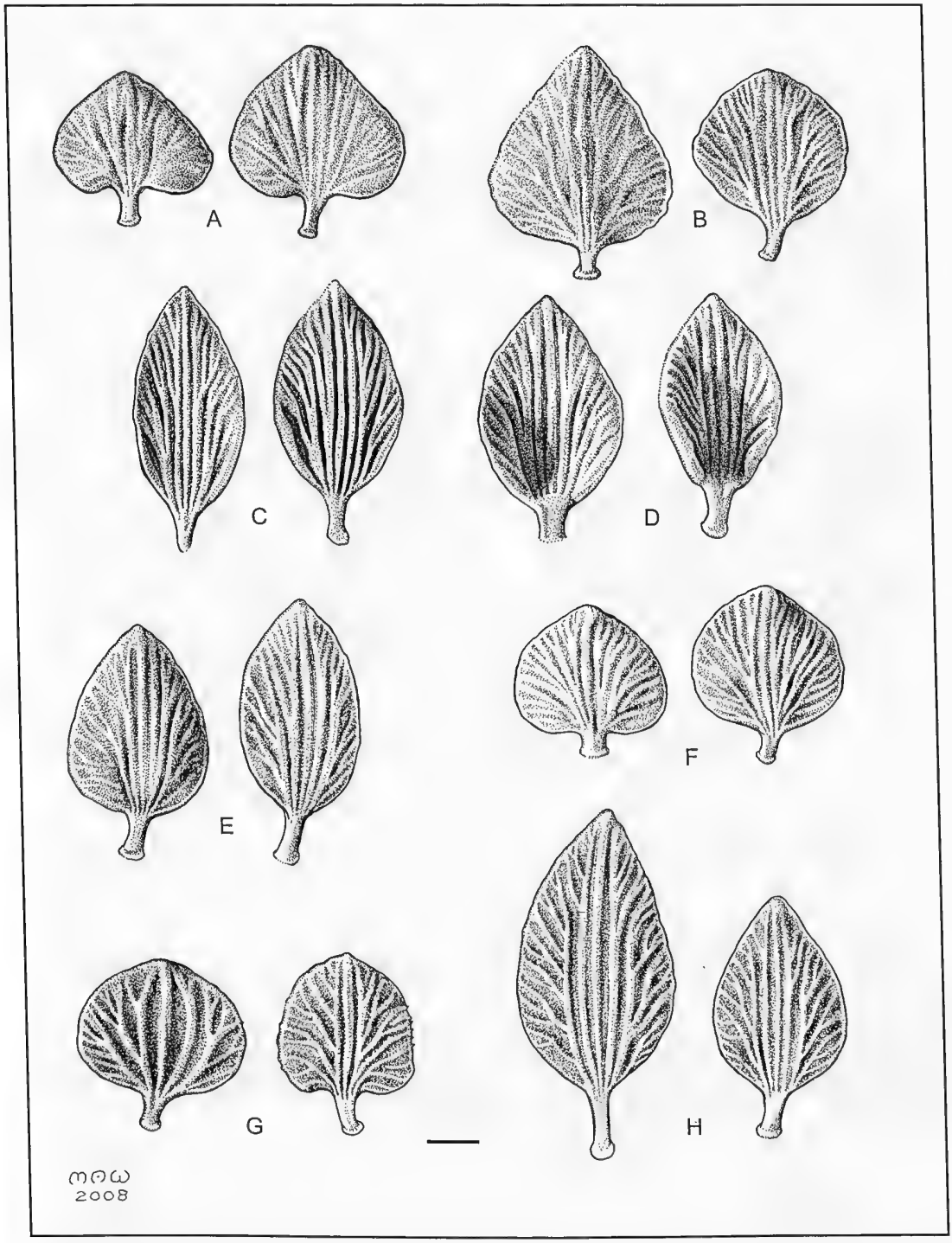

Figure 4. *Leucopogon heterophyllus*. Examples of variation in leaf morphology (abaxial surfaces shown) within and between populations. Scale bar: 1 mm. Drawn by Margaret Wilson from *M. Hislop* 3704 (A), *M. Hislop* 3114 (B), *M. Hislop* 3711 (C), *M. Hislop* 3228 (D), *M. Hislop* 3741 (E), *M. Hislop* 3713 (F), *M. Hislop* 3621 (G), *M. Hislop* 3721 (H).

Other specimens examined. WESTERN AUSTRALIA: 1.6 km along track leaving Esperance Rd at 30.5 km from Ravensthorpe to NE, 17 May 1998, *M. Bennett* 141 (PERTH); 6.25 km south along West Point Rd from intersection with Rawlinson Rd, 22 Oct. 1997, *E.A. Brown* 97/380, *P.G. Wilson & N. Lam* (CANB, CHR, NSW, NY, PERTH, UNSW); 35.5 km ENE of Muckinwobert Rock, 6.21 km NE of Melaleuca Rd on West Point Rd, 30 Sep.1984, *M.A. Burgman* 3920 (PERTH); 8.5 km NW of Ravensthorpe and Esperance shire boundary on Cascades Rd, proposed MRD gravel pit no. 2 on east side, 25 July 1995, *G.F. Craig* 3246 (PERTH); 35.5 km ENE of Muckinwobert Rock, 6.21 km NE of Melaleuca Rd on West Point Rd, 30 Sep.1984, *M.A. Burgman* 3936 (PERTH); Lake King – Cascades Road, 23.2 km NW of West Point Rd, NW of Cascade, 25 July 2006, *M. Hislop* 3621 (CANB, NSW, PERTH); South Coast Highway 30 km E of Ravensthorpe and then 100 m N along rough track, 27 Apr. 2007, *M. Hislop* 3704 (CANB, NSW, PERTH); West Point Rd, 12.8 km W of Cascades Rd, NW of settlement of Cascade, 26 June 2007, *M. Hislop* 3710 (CANB, NSW, PERTH); Melaleuca Rd 300 m S of West Point Rd, NW of settlement of Cascade, Western Australia, 26 June 2007, M. Hislop 3711 (CANB, K, MEL, NSW, PERTH); Coujinup Rd 6.9 km N of South Coast Highway, E of Ravensthorpe, 27 June 2007, *M. Hislop* 3714 (CANB, PERTH); Lake King – Cascades Rd, 36.7 km SE of Lake King – Norseman Rd, 15 Aug. 2007, *M. Hislop* 3721A & 3721B (CANB, NSW, PERTH); unmanaged Reserve No 29713, West Point Rd, 12 km N of South Coast Highway, NW of Munglinup, 21 Oct. 2007, *M. Hislop* 3737 (CANB, NSW, PERTH); Melaleuca Rd 300 m S of West Point Rd, NW of settlement of Cascade, 21 Oct. 2007, *M. Hislop* 3739 (NSW, PERTH); West Point Rd, 12.8 km W of Cascades Rd, NW of settlement of Cascade, 21 Oct. 2007, *M. Hislop* 3740 (CANB, PERTH); Lake King – Cascades Rd, 36.7 km SE of Lake King – Norseman Rd, 21 Oct. 2007, *M. Hislop* 3741 (CANB, PERTH); 1 km W of Burlabup Ck on Esperance – Ravensthorpe Rd, 35 km E of Ravensthorpe, 16 Nov. 1981, *K.R. Newbey* 9409 (PERTH); 1 km W of Burlabup Ck on Esperance – Ravensthorpe Road, *c.* 33 km E of Ravensthorpe, 27 Sep. 1968, *P.G. Wilson* 8003 (CANB, PERTH).

Distribution and habitat. Leucopogon heterophyllus extends from a little east of Ravensthorpe to the Cascade area and north at least as far as the Lake King – Cascade Rd (Figure 2). It generally occurs in sandy loam soils, often over laterite, and as a component of the shrubby understorey of open mallee woodlands.

Phenology. The main flowering period is between May and July. Mature fruit has been collected between late September and November.

Etymology. The epithet is derived from the Greek *heteros* (different or unequal) and *phyllon* (leaf), in reference to the particularly variable leaf morphology of this species.

Conservation status. Although not widespread, *Leucopogon heterophyllus* occurs in an area of southern Western Australia where there remain extensive tracts of uncleared land. Its preferred habitat is locally common in that area and the known populations are generally large. For these reasons it is not recommended, at this stage, for inclusion on the DEC's Priority list.

Affinities. Leucopogon heterophyllus is most closely related to *L. bossiaea*, variants with broadly ovate, often cordate leaves being especially similar to that species. The two differ primarily in flower size, with the new species having larger floral parts: sepals 1.9–2.6 mm long and 1.1–1.6 mm wide (compared to 1.4–1.9 mm and 0.8–1.2 mm respectively in *L. bossiaea*), corolla tube 1.3–2.0 mm long (1.1–1.5 mm), corolla lobes 1.9–3.5 mm long (1.5–2.0 mm), corolla lobe to tube ratio 1.4–2: 1 (1.0–1.4: 1), style 0.6–0.9 mm long (0.4–0.5 mm), and ovary dimensions 0.6–0.7 mm long by 0.6–0.8 mm wide (0.5–0.6 mm by 0.5–0.6 mm). The fruit of *L. heterophyllus* are also larger; 1.7–2.1 mm long

and 1.8–2.3 mm wide, compared with 1.4–1.6 mm by 1.3–1.5 mm in *L. bossiaea*. The two species are allopatric, being separated by between 250 and 300 km.

Variants of *L. heterophyllus* with longer, elliptic leaves may resemble *Leucopogon remotus*, which is described below, but can be separated by consistent foliar differences. These two species are also allopatric, with the latter having a restricted distribution north-east of Esperance. The leaves of *L. remotus* are usually distinctly concave adaxially, less often flat, and are characterized by having the lamina markedly incurved along the longitudinal axis and in having a straight, acute apex. The longer-leaved variants of *L. heterophyllus* by contrast have generally narrower leaves (i.e. the length to width ratio of longest leaves is 1.36–2.55: 1, compared to 2.64–3.89: 1 in *L. remotus*), which are either flat, adaxially convex or with manifestly recurved margins. The longitudinal axis of the lamina is ± straight, and the apex obtuse or subacute and often slightly deflexed. The fruit of *L. remotus* are also smaller.

Notes.Three more or less recognisable, geographical variants occur across the species' range. The western populations between the eastern end of the Ravensthorpe Range and the Oldfield River have relatively short, broadly ovate leaves (always with many leaves wider than long), and cordate, truncate or rounded bases. Leaf curvature is either flat, slightly concave adaxially or slightly convex and the main veins on the abaxial surface are usually moderately raised with broad shallow grooves between.

East of the Oldfield River occurs a second variant in which the leaves are always longer than broad, often distinctly so, usually ovate or elliptic in shape, occasionally obovate, and flat, adaxially convex, or with manifestly recurved margins. The bases are cuneate or rounded, and the veins on the abaxial surface are more prominently raised with the intervening grooves deeper and narrower than in the western variant.

The foliar differences between the two variants described above are quite consistent and were the species only known from these areas there might be grounds for recognising a second taxon. However this pattern of foliar difference breaks down in collections from the northern populations, even though these appear to be more isolated geographically from both the eastern and typical variants than those are from each other. Plants collected along the Lake King – Cascade Road have leaves with generally higher length to width ratios than the western populations, but not as high as those seen in the easternleaf venation and shape of the leaf base are also generally intermediate.

At the south-eastern edge of the species' range there occurs a population (represented by *M. Hislop* 3712) which, even within the context of such a variable species, stands out as being significantly different. It has the majority of leaves linear or narrowly obovate, with more or less tightly recurved margins and deep, narrow grooves between the prominent veins on the abaxial surface. In general foliar morphology, it is similar to the species pair *Leucopogon canaliculatus* and *L. rugulosus* (described elsewhere in this paper), although both are readily separated by the hairs in the abaxial grooves. It is not clear at this stage whether this entity should be regarded as an anomalous variant of either *L. heterophyllus* (it is not included in the above description of the species) or *L. canaliculatus* or as a separate taxon.

The plasticity of the foliar morphology of this species is unusual and beyond the range encountered elsewhere in Group A. The leaves not only vary very considerably in shape but also in curvature and in the prominence of the abaxial venation. The pattern of foliar variation however shows very little correlation with any potential differences in the flowering or fruiting morphology.

Leucopogon heterophyllus occurs in large part in uncleared and untracked country. A better understanding of its pattern of variation may have to wait until the area has been more fully explored botanically.

Leucopogon remotus Hislop, *sp. nov.*

Leucopogi bossiaea (F. Muell.) Benth. affinis a qua imprimis differt foliis longioribus angustioribus et magis acutis, basi cuneata vice cordatae vel rotundatae.

Typus: North-east of Esperance [precise locality withheld for conservation reasons], Western Australia, 26 July 2006, *M. Hislop* 3627 (*holo*: PERTH 07350597; *iso*: CANB, NSW).

Leucopogon sp. South Coast (K.R. Newbey 8213), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 240 (2000).

Erect, usually rather compact *shrubs* to *c.* 70 cm high and 70 cm wide, but usually shorter, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* glabrous or with a sparse indumentum of very short patent hairs < 0.1 mm long, which may persist to the second or third year, at length glabrescent; bark on older stems dark grey and becoming fissured. *Leaves* spirally arranged, antrorse, usually steeply so, narrowly ovate to ovate, less often narrowly elliptic to elliptic, 4.0–9.5 mm long, 1.9–3.0 mm wide; apex acute, with a short pale callus point; base cuneate; petiole well-defined, greenish-yellow or pale brown, 0.9–1.7 mm long, glabrous or with a few short hairs on the adaxial surface, glabrous abaxially; lamina 0.30–0.45mm thick, usually concave adaxially, less often flat, incurved along longitudinal axis, especially towards the apex; surfaces slightly discolorous, glabrous, adaxial surface not or scarcely shiny, mid-green, venation not evident, abaxial surface paler with 5–7 prominently raised primary veins, the midrib not differentiated; margins usually coarsely ciliolate with antrorse hairs, less often glabrous. *Inflorescence* erect, usually terminal, with little upper-axillary development; axis 3–9 mm long, with 4–11 flowers terminating in a bud-like rudiment; indumentum of sparse to moderately dense, patent hairs < 0.1 mm long; flowers erect and sessile. *Fertile bracts* ovate to broadly ovate, 1.0–1.2 mm long, 0.8–1.0 mm wide, obtuse; abaxial surface glabrous, venation usually obscure; adaxial surface sparsely hairy; margins ciliolate. *Bracteoles* ovate, 1.1–1.6 mm long, 0.7–1.1 mm wide, obtuse or subacute, keeled; abaxial surface glabrous apart from a few short hairs near the keel apex, greenish-grey and often suffused reddish-purple along the central portion, becoming scarious towards the margins; adaxial surface appressed, antrorse-hairy; the margins ciliolate. *Sepals* ovate, 1.7–2.1 mm long, 1.0–1.3 mm wide, obtuse or subacute; abaxial surface glabrous, greenish in lower central portion, becoming suffused a dull purple above, venation obscure, apart sometimes from a pale midrib close to the apex; adaxial surface with appressed, antrorse hairs; margins broadly scarious and ciliolate with hairs < 0.1 mm long. *Corolla tube* white, broadly campanulate, usually longer than sepals by up to 0.6 mm, or occasionally *c.* as long as sepals, 1.3–2.0 mm long, 1.7–2.0 mm wide, glabrous externally and internally except for a few hairs below the base of the lobes. *Corolla lobes* white, sometimes flushed pink towards apex, slightly longer than the tube (ratio = 1.1–1.5: 1), widely spreading from the base and recurved, 2.0–2.3 mm long, 0.8–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.5–0.6 mm long near apex, glabrous tip 0.1–0.2 mm long. *Anthers* partially exserted from tube (by 2/3–3/4 of length) in early stages of flowering but often becoming fully exserted and held ± at right angles to the floral axis, 1.0–1.5 mm long, slightly recurved at apex; sterile tips inconspicuous, 0.3–0.4 mm long; *filaments* terete, attached 1/2–2/3 above anther base, 0.4–0.6 mm long, adnate to tube just below the sinus. *Ovary* depressed-globose or globose, 0.5–0.7 mm long, 0.6–0.7 mm wide, glabrous, 3–4(–5)-locular; *style* 0.5–0.7 mm

long, tapering smoothly from a broad base (0.3–0.4 mm wide) to the stigma, included within corolla tube; *stigma* not or very slightly expanded; *nectary* annular, 0.3–0.5 mm long, shallowly lobed for up to 1/3 of length, glabrous. *Fruit* depressed-globose, with smoothly rounded shoulders, glabrous, 1.4–1.6 mm long, 1.6–1.7 mm wide, longer than calyx, the surface with a moderately conspicuous reticulum of transverse and longitudinal ridges; style persistent. (Figure 3D–F)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 10 Oct. 2007, *R. Butcher & J.A. Wege* RB 1212 (PERTH); 14 Nov. 1993, *G.F. Craig* 3020A &3020B (ESP, PERTH); 30 June 2006, *R. Davis* 11089 (PERTH); 26 July 2006, *M. Hislop* 3629 (CANB, NSW, PERTH); 16 Aug. 2007, *M. Hislop* 3722 (CANB, NSW, PERTH); 8 Nov. 1980, *K.R. Newbey* 8213 (PERTH).

Distribution and habitat. Leucopogon remotus is known only from a restricted area north-east of Esperance, where it grows on sandy-loam soils in mallee woodland communities. (Figure 2).

Phenology. Flowering specimens have been collected in June and July, but it is likely that flowering continues at least through much of August and maybe into early September. Mature fruit has been collected in October and November.

Etymology. Named from the Latin *remotus* (distant, remote). A reference to the remote, very sparsely populated country in which the species is endemic.

Conservation status. This species was originally listed under the phrase name *Leucopogon* sp. South Coast (K.R. Newbey 8213) and is currently assigned Priority One status in the Conservation Codes for Western Australian Flora (Atkins 2008). Although currently known only from a few populations in a restricted area north-east of Esperance, these are very close to the edge of the agricultural zone and it does seem probable that the species will also occur to the north of the clearing line. If future surveys are able to confirm this, its conservation status will need to be reassessed, as there are no obvious threats to the known populations.

Affinities. The new species clearly belongs to the *Leucopogon bossiaea* subgroup, with its two closest relatives being *L. bossiaea* and *L. heterophyllus*. The former differs from *L. remotus* in its shorter, obtuse leaves which have broadly rounded or cordate rather than cuneate bases. Differences between *L. remotus* and *L. heterophyllus* are discussed under that species.

Leucopogon rugulosus Hislop, *sp. nov.*

Leucopogi canaliculato Hislop affinis sed foliis et inflorescentiis brevioribus, ovario 3-(nullomodo 4–5-) loculari differt.

Typus: North-west of Esperance [precise locality withheld for conservation reasons], Western Australia, 17 May 2002, *M. Hislop & F. Hort* MH 2601 (*holo*: PERTH 06132820; *iso*: CANB, NSW).

Leucopogon sp. Roberts Swamp (K.R. Newbey 8173), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 240 (2000).

Erect *shrubs* to *c.* 100 cm high and 100 cm wide, single-stemmed at ground level and with a fire-sensitive rootstock. Young *branchlets* light brown, with a sparse to moderately dense indumentum of

patent, straight or somewhat decurved hairs to 0.2 mm long, which are persistent to the second or third year but at length glabrescent, the mature stems becoming grey with smooth or slightly fissured bark. *Leaves* spirally arranged, usually slightly antrorse, less often more steeply so or ± patent (always spreading from a steeply antrorse petiole), obovate or elliptic, 1.7–3.1 mm long, 1.1–1.7 mm wide; apex with a blunt, recurved mucro to *c.* 0.2 mm; base rounded or cordate; petiole well defined, greenish-yellow, 0.3–0.5 mm long, with a dense indumentum of short, patent hairs throughout; lamina 0.35–0.45 mm thick, margins revolute, often abutting abaxially in lower half; surfaces discolorous, adaxial surface shiny, with irregular transverse wrinkles and a sparse or moderately dense indumentum of short, slightly antrorse hairs, usually persistent but sometimes glabrescent, venation not evident, abaxial surface paler with 5–7 broad, primary veins and deep furrows between, the midrib not differentiated, densely hairy with short patent hairs throughout; margins irregularly scabrous with patent and antrorse hairs. *Inflorescence* erect, terminal and upper-axillary; axis 3–9 mm long, with 3–9 flowers, terminating in a bud like rudiment; indumentum of dense, patent, straight hairs, 0.08–0.1 mm long; *flowers* erect, sessile. *Fertile bracts* ovate or broadly ovate, usually with a cordate base, 0.9–1.3 mm long, 0.8–1.1 mm wide, subacute or acute; abaxial surface with irregular indumentum of short patent hairs, venation usually obscure; adaxial surface with appressed antrorse hairs. *Bracteoles* ovate, 1.1–1.7 mm long, 0.9–1.3 mm wide, acute, keeled; abaxial surface with short, moderately dense, patent hairs along keel, and a shorter irregular indumentum elsewhere, pale greenish in basal portion, usually suffused red-purple along the keel and in a sub-marginal band; adaxial surface appressed antrorse-hairy; margins scarious and ciliolate. *Sepals* ovate, 1.9–2.3 mm long, 1.1–1.5 mm wide, acute or subacute; abaxial surface glabrous and greenish in lower, central portion, very shortly antrorse-hairy and red or brownish purple above, venation obscure apart from the pale midrib which is usually evident close to apex; adaxial surface appressed antrorse-hairy for most of length; margins scarious and ciliolate with hairs to 0.15 mm long. *Corolla tube* white, campanulate, as long as sepals or shorter (by up to 0.3 mm), 1.3–1.9 mm long, 1.4–1.7 mm wide, glabrous externally and internally. *Corolla lobes* white, sometimes flushed pink towards apex, slightly longer than the tube (ratio = 1.1–1.4: 1), widely spreading from base and recurved, 1.7–2.5 mm long, 0.8–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.6–0.8 mm long near apex, the basal hairs reflexed into top of tube by up to 0.8 mm, the glabrous tip 0.1–0.2 mm long. *Anthers* of recently opened flowers partially exserted from tube (by 1/2–2/3 of length) but then often becoming fully exserted and held at right angles to the floral axis, 1.0–1.4 mm long, slightly recurved at apex; sterile tips inconspicuous, 0.2–0.3 mm long; *filaments* terete, attached 2/3 to 3/4 above anther base, 0.4–0.6 mm long, adnate to tube just below sinus. *Ovary* depressed-globose or globose, 0.5–0.6 mm long, 0.5–0.7 mm wide, glabrous, 3(4)-locular; *style* 0.4–0.6 mm long, tapering smoothly from a broad base (*c.* 0.3 mm wide), included within the corolla tube; *stigma* scarcely to distinctly expanded; *nectary* annular, 0.2–0.35 mm long, lobed for up to 1/3 of length, glabrous. *Fruit* depressed-globose or globose, with smoothly rounded shoulders, glabrous, 1.5–1.6 mm long, 1.6–1.8 mm wide, slightly shorter than to slightly longer than calyx, the surface with a rather conspicuous reticulum of transverse and longitudinal ridges, the style persistent.(Figure 3G–I)

Other specimens examined. WESTERN AUSTRALIA: 16 Dec. 2005, *E.D. Adams* 13/1205 (PERTH); 24 May 1983, *M.A. Burgman & S. McNee* 1482 (NSW, PERTH); 6 May 2003, *J. A. Cochrane s.n.* (PERTH); 19 Sep. 1993, *G.F. Craig* 2953, 2953A, 2953B, 2953C (PERTH); 19 Sep. 1993, *G.F. Craig* 2960A, 2960B, 2960C (PERTH); 15 Nov. 1980, *K.R. Newbey* 8173 (PERTH); 13 Aug. 1997, *W. O'Sullivan* 246 (PERTH); 5 Jun. 2000, *W. O'Sullivan* 960 (NSW; PERTH).

Distribution and habitat. Leucopogon rugulosus appears to have a very restricted distribution in the Cascades area NW of Esperance (Figure 2). It grows on sandy or sandy loam soils in heathland or open mallee woodland, and in generally low lying areas sometimes quite close to saline drainage lines.

Phenology. Appears to flower over an extended period beginning in May or earlier and continuing until at least September by which time mature fruit are also present.

Etymology. From the Latin *rugosus* (wrinkled or creased) with diminutive *–ul* (slightly), in reference to the transverse wrinkling which is characteristic of the upper leaf surface of this species.

Conservation status. Under the phrase name *Leucopogon* sp. Roberts Swamp (K.R. Newbey 8173), this species has been assigned Priority One under DEC Conservation Codes for Western Australian Flora (Atkins 2008). It is known only from a small area of the south coast of Western Australia. However this is remote, and in botanical terms, poorly known country with large areas of undisturbed natural vegetation. The true distribution of the species may be larger than currently appears the case. Aside from the now unlikely possibility of a resumption of land clearing in the area, there are no obvious threats to the known populations.

Affinities. The closest relative of *Leucopogon rugulosus* is *L. canaliculatus*. Distinguishing features between the two are discussed under that species.

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I am grateful to my colleague Juliet Wege for critically examining the holotype of *Leucopogon bossiaea* currently on loan to NSW and providing distribution maps.

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Six new and rare species of *Darwinia* (Myrtaceae) from Western Australia

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Abstract

Keighery, G.J. Six new and rare species of *Darwinia* (Myrtaceae) from Western Australia. *Nuytsia* 19(1): 37–52 (2009). *Darwinia chapmaniana* Keighery, *D. foetida* Keighery, *D. ferricola* Keighery, *D. nubigena* Keighery, *D. polychroma* Keighery and *D. whicherensis* Keighery are newly described. All of these species are endemic in south-west Western Australia and are considered endangered under the Western Australian *Wildlife Conservation Act 1950*.

Introduction

Darwinia Rudge (Myrtaceae) is an endemic Australian genus of *c.* 70 species. It is part of a closely related group of genera (*Actinodium* Schauer, *Chamelaucium* Desf., *Darwinia*, *Verticordia* DC. and *Pileanthus* Labill.) which have diversified in southern Western Australia. Sixty species of *Darwinia* are recognised in Western Australia, of which more than half have not been formally described but are flagged as manuscript or phrase names on the Western Australian plant census (Western Australian Herbarium 1998–). Orchard (2006) raised concerns about the perpetuation and de-facto validation of such informal names in the literature noting that 'in many cases these "temporary" names are still in use 10–15 years later'. This paper begins to address these concerns by formally describing six rare species of *Darwinia* from Western Australia.

Methods

Locality information for all taxa has been omitted for conservation purposes. The distribution maps were compiled using DIVA-GIS Version 5.2.0.2, available at www.diva-gis.org/, and are based on PERTH specimen data.

The genus *Darwinia* has not been revised in total since Bentham (1865). In this treatment species are placed closest to those groups distinguished in his treatment on the basis of morphological characters. Current work by Matthew Barrett on the molecular relationships of the entire '*Chamelaucium* clade' will greatly aid generic and subgeneric placement.

Taxonomy

Darwinia chapmaniana Keighery, *sp. nov.*

Frutex 50 cm altus et 3 m latus. Folia linearia, triquetra, pilifera, aggregata apice, cinerascentia, 2–3 mm longa, acuta, margine ciliata. Capitulum terminale, erectum, bracteae involucri pluri-seriales, 4–7 mm longae, rubro-luteae, marginibus pilis longiusculis, instructis. Stylus erectus vel curvatus, 8–10 mm longus.

Typus: WSW of Coorow, Western Australia [precise locality withheld for conservation reasons], 16 October 1981, *G.J. Keighery* 4216 (*holo*: PERTH 01351753).

Darwinia chapmaniana N.G.Marchant ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 360 (2000); A. Brown, C. Thomson-Dans, N. Marchant, *West. Austral. Threat. Fl.*: p. 78 (1998), *nom. inval.*

Darwinia sp. Coorow (B.A. Fuhrer 96/54), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed April 2008].

Illustration. Brown *et al.* (1998), p. 78.

A low, domed, much branched, spreading *shrub,* from a rootstock, to 50 cm tall and up to 3 m wide. Young branches slender, brown, with prominent decurrent leaf bases, becoming grey and woody. *Leaves* crowded at the ends of branches, scattered to absent on main stems, grey-green, linear, erect, covered in short hairs, triangular in section, 2–3 mm long, margin ciliate. *Floral leaves* grey, flattened. *Inflorescence* a terminal head usually composed of 12–16 flowers, erect or spreading, surrounded by red/yellow bracts, 9–15 cm in diameter, curry-scented. *Inflorescence bracts* in several layers, leaf-like to linear with an expanded base, longest before flowers are red-yellow, covered in long, red-yellow hairs on margins, 4–7 mm long. *Flowers* yellowish, floral tube 3–4 mm long, reddish with five indistinct ribs. Each flower base enclosed by two floral bracts, cymbiform, ovate when spread, brown, scarious, 4–5 mm long, acuminate. *Calyx lobes* narrowly ovate, small, *c.* 1 mm long, margin ciliate. *Petals* trullate-obovate, *c.* 2 mm long, margin dentate, apex acute. *Stamens* 10, *c.* 1 mm long. *Staminodes* 10, as long as staminal filaments. *Style* incurved, exserted beyond bracts, 8–10 mm long, yellow-red, apex subtended by a ring of hairs. *Ovules* 2. (Figure 1)

Selected specimens examined. WESTERN AUSTRALIA: 7 Dec. 1968, *C. Chapman s.n.* (PERTH); 4 Nov. 1976, *C. Chapman s.n.* (PERTH); 1 Oct. 1982, *J. Coleby-Williams* 122 (PERTH); 9 Oct. 1982, *J. Coleby-Williams* 157 (PERTH); 1 Sep. 1996, *D. Papenfus & R. Anderson* DP534 (PERTH).

Distribution. Found in a small area west of Coorow and Marchagee (Figure 2A).

Habitat. Occurs on shallow red or yellow clay-loam over sandstone or calcrete, around the edges of saline lakes in winter damp flats under mixed mallee or *Melaleuca* shrubland.

Phenology. This species flowers in mainly in spring (September to November), but a few flowers can be found as late as December.

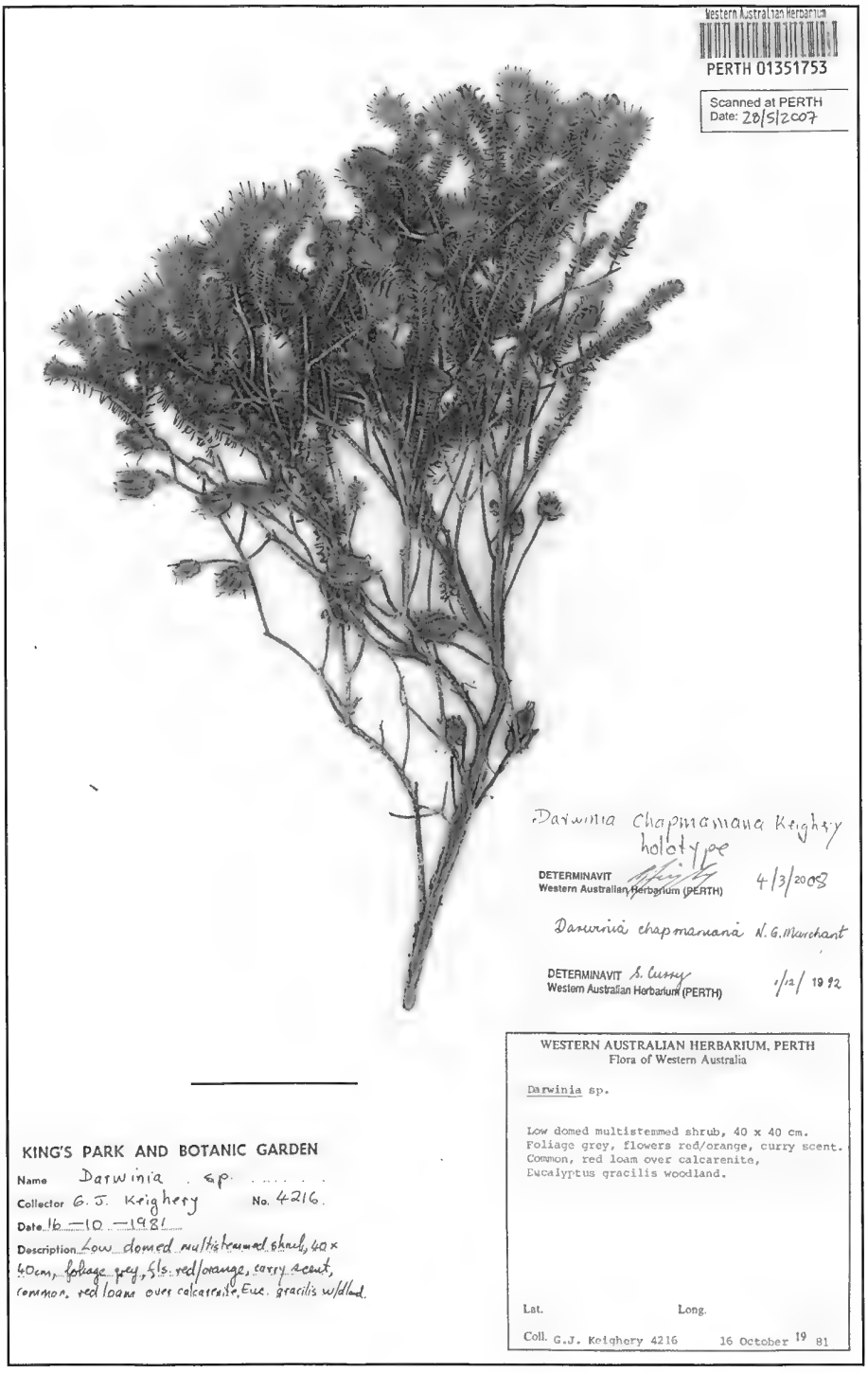

Figure 1. Holotype of *Darwinia chapmaniana*, scale = 5 cm.

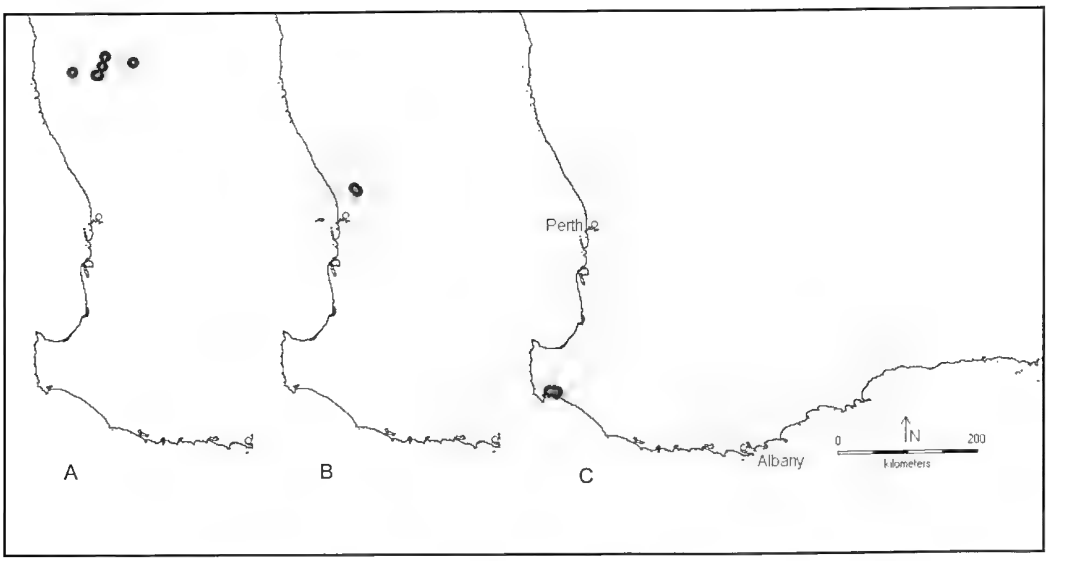

Figure 2. Distribution of *Darwinia* in Western Australia. A – *D. chapmaniana*; B – *D. foetida*; C – *D. ferricola*.

Conservation status. Listed as Declared Rare Flora under the Western Australian *Wildlife Conservation Act 1950*. This species is currently listed as Vulnerable, however, consideration should be given to upgrading its status to Endangered as it is threatened by rising saline groundwater throughout its range.

Etymology. Named after Charles Chapman, farmer, collector and wildflower enthusiast from Winchester, who first collected this species.

Common name. Chapman's Bell or Eganu Bell.

Affinities. Probably related to *D. neildiana*, in which it was once placed on the basis of the rounded, pendulous inflorescences with flowers enclosed by the bracts. This bird pollinated group has speciated on the northern sandplains and the morphological characters uniting them are largely related to this pollination syndrome. *Darwinia neildiana* however, is a small erect shrub with large, pendulous inflorescences surrounded by red bracts. Unlike *D. neildiana* this species has grey leaves with a ciliate margin. Unlike many other *Darwinia* species this species also has distinctly curry-scented leaves and flowers.

Darwinia foetida Keighery, *sp. nov.*

Frutex 40–70 cm altus. Folia linearia, triquetra, 3–5 mm longa, reflexa, acuta. Capitulum terminale, magnum, nutans, bracteae exteriores involucrorum pluri-seriales, 18–27 mm longae, rubrae in centro laminarum, marginibus pilis longiusculis instructis. Bracteolae lineares, acutae. Tubus floralis cylindricus, durus, *c.* 3 mm longus. Lobi corollae ovati, *c.* 1 mm longi. Stamina 10. Stylus curvatus, 10–16 mm longus.

Typus: Muchea, Western Australia [precise locality withheld for conservation reasons], 17 November 1994, *B.J. Keighery* 2458 (*holo*: PERTH 06019749; *iso*: CANB, MEL, NSW).

Darwinia sp. A Perth Flora (A.S. George 16943), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.*: *Descr. Cat.* p. 361 (2000).

Darwinia foetida N.G.Marchant & Keighery ms, Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed April 2008].

Darwinia sp. Muchea (B.J. Keighery 2458), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed April 2008].

An erect or spreading *shrub* to 70 cm tall, often using other shrubs for support. Young branches slender, green-brown with prominent, decurrent leaf bases, becoming grey and woody. *Leaves* linear, triangular in section, green, hairless, crowded at ends of branches, reflexed, 3–5 mm long, apex acute, margin entire. *Inflorescence* terminal, nodding or rarely erect in young plants, composed of 12–15 flowers, which do not exceed the floral bracts. *Bracts* enclosing the flowers in several rows, leaf-like to linear with an expanded base, the longest red in centre, green on margins, margins with long hairs, 18–27 mm long, enclosing the flowers. Each flower base enclosed by two floral bracts, cymbiform, ovate when spread, brown, scarious, 2–3 mm long, acuminate. *Floral tube* brown, with 5 ribs, 3 mm long. *Calyx lobes* triangular, small, *c.* 1 mm long. *Petals* trullate-obovate, *c.* 1 mm long, acute, entire. *Style* curved, slightly dilated at base, 12–16 mm long, red, end tapering to apex subtended by a ring of hairs. *Ovules* 2. (Figure 3)

Selected specimens examined. WESTERN AUSTRALIA: 28 Oct. 1960, *A.S. George* 1693 (PERTH); 3 Nov. 1995, *B.J. Keighery* 2345 (PERTH); Dec. 1927, *H. Steedman s.n.* (PERTH).

Distribution. A localised distribution near Muchea (Figure 2B).

Habitat. Occurs on grey-black sandy rises in winter-damp to wet clay flats under *Regelia inops–Kunzea recurva* tall shrubland over *Hypocalymma angustifolium* low shrubland or low *Melaleuca* shrubland.

Phenology. Flowers in late spring (October to November).

Conservation status. Listed as Declared Rare Flora under the Western Australian *Wildlife Conservation Act 1950.*

Etymology. This species is named after the distinctive foetid smell of the flowers.

Common name. Muchea Bell.

Affinities. Probably related to *D. neildiana*, (the only described member of the group) in which it was once placed on the basis of the rounded, pendulous inflorescences with flowers enclosed by the bracts. This bird pollinated group has speciated on the northern sandplains and the morphological characters uniting them are largely related to this pollination syndrome. *Darwinia neildiana* however, is a small erect shrub with large, pendulous inflorescences surrounded by red bracts. *Darwinia foetida* differing in the lax, spreading habit, smaller inflorescences with a foetid scent and red-green dull bracts compared to the bright red bracts of *D. neildiana.*

Notes. Killed by fire, regenerates from seed, flowering from two years after a summer fire.

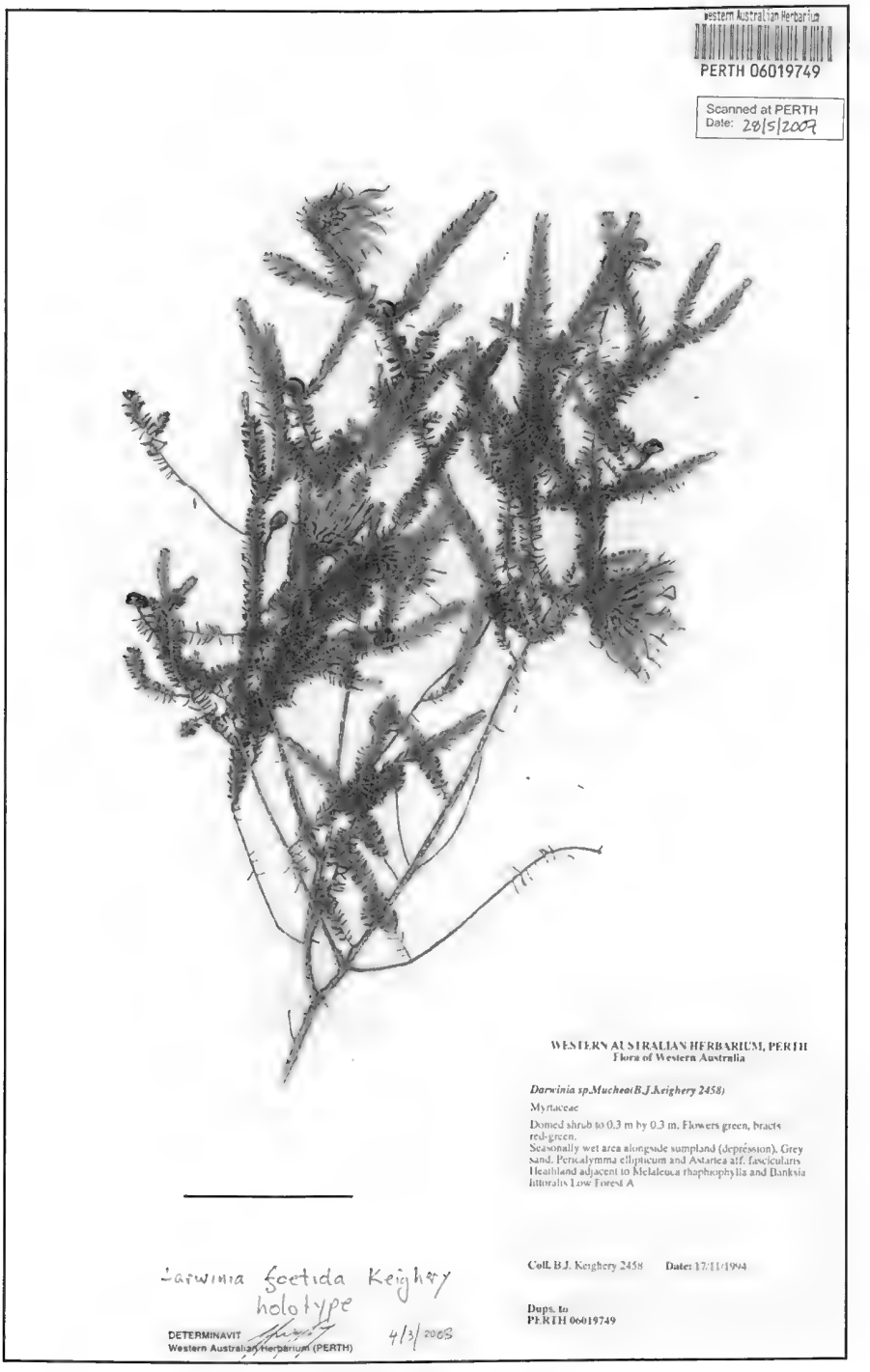

Figure 3. Holotype of *Darwinia foetida*, scale = 5 cm.

Darwinia ferricola Keighery, *sp. nov.*

A *D. apiculata* N.G.Marchant differt brevibus bracteis inflorescentiae (5–7 mm versus 10–15 mm), floribus numerosis inflorescentiam (14–22 versus 4–8) et stylo longiore (12–15 mm versus 6–9 mm).

Typus: Scott River, Western Australia [precise locality withheld for conservation reasons], 18 November 1980, *G.J. Keighery* 3582 (*holo*: PERTH 01357085; *iso*: CANB, NSW).

Darwinia ferricola N.G.Marchant ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 360 (2000); A. Brown, C. Thomson-Dans, N. Marchant, *West. Austral. Threat. Fl.*: 136 (1998), *nom. inval.*

Darwinia sp. Scott River (G.J. Keighery 3582), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed April 2008].

Illustration. Brown *et al.* (1998), p. 136.

A large, much branched, semi-climbing or rounded *shrub,* to 1.5 m tall ×1 m wide. Young branches slender, greenish-brown with prominent, decurrent leaf bases. *Leaves* densely packed on the ends of branches, scattered to leafless on main stems, spreading to recurved when mature, linear-triquetrous in section, adaxial surface convex, with slightly raised keel, hairless, green, apex acute, margin entire, petioles 0.1–0.2 mm long, lamina 2–5 mm long on young stems, 5–7(–9) mm on mature stems. *Floral leaves* green, flattened, 5–8 mm long. *Inflorescence* a terminal, globular head of (14–)20–40 flowers in which the styles greatly exceed the floral bracts, usually erect at the ends of branches, 20–30 mm diameter. *Floral bracts* in several layers, leaf-like to linear with an expanded base below the flowers, yellow-green, flowers extending beyond the floral bracts. Outer involucral bracts narrowly ovate, long acuminate, triquetrous, 5–7 mm long, green or greenish-red, flattened at base. Inner involucral bracts narrowly ovate, long acuminate, 5–7 mm long, greenish-yellow or greenish-red, adaxial surface deeply concave. Each flower base enclosed by two floral bracts, cymbiform, ovate when spread, brown, scarious, 3–4 mm long, 1–2 mm wide, acuminate. *Floral tube* obconical, yellow green, with 5 indistinct ribs, 2–3 mm long. *Calyx lobes* narrowly ovate to triangular, small, 2 mm long, 1 mm wide, entire, apex obtuse. *Petals* trullate-obovate, *c.* 3 mm long, 1–2 mm wide, acute, entire, margins slightly involute. *Stamens* 10, filaments slightly dilated at base, fused to staminodes in lower half, *c.* 1 mm long. *Staminodes* 10, as long as staminal filaments, narrowly triangular, margins coarsely divided. *Style* straight or slightly curved inward, slightly dilated towards base, 12–15 mm long, often reddish, tapering to apex which is subtended by a ring of hairs, *c.* 1 mm wide. *Ovules* 2. (Figure 4)

Selected specimens examined. WESTERN AUSTRALIA: 17 Dec. 2002, *J.A. Cochrane* 4370 (PERTH); 3 May 1989, *G.S. McCutcheon* 2040 (PERTH); 20 Nov. 1996, *A. Webb* 16 (PERTH).

Distribution. Confined to the Scott Coastal Plain, east of Augusta (Figure 2C).

Habitat. Usually shallow red or brown clays over winter-wet ironstone, with one record from shallow sand over ironstone. Normally in tall *Hakea tuberculata* shrubland over *Dryandra nivea* shrubs over *Loxocarya magna* and *Chordifex isomorphus* sedgeland.

Phenology. Flowers from late winter to early summer, with a peak in spring.

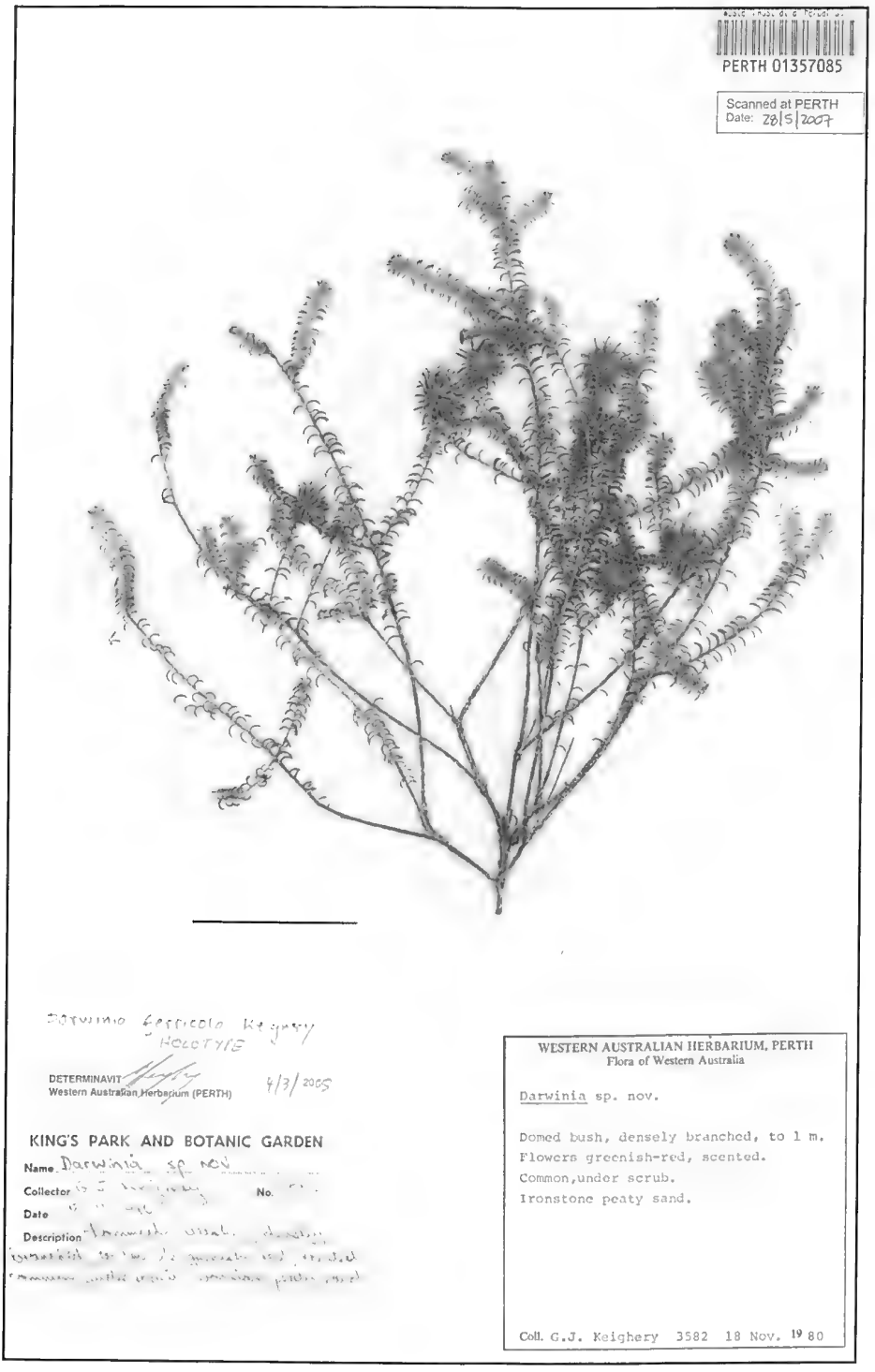

Figure 4. Holotype of *Darwinia ferricola*, scale = 5 cm.

Conservation status. Listed as Declared Rare Flora under the Western Australian *Wildlife Conservation Act 1950* with a ranking of Endangered (Atkins 2008).

Etymology. This specific epithet refers to this species habitat preference (iron inhabitant).

Common name. Scott River Darwinia.

Affinities. Part of the *Darwinia oederoides* complex (Bentham 1865), which comprises *D. apiculata*, *D. oederoides*, *D. ferricola* and *D. whicherensis*. Closely related to *D. apiculata* and *D. oederoides*, but this is a much larger shrub, lacking apiculate leaves, with over double the number of flowers in the inflorescence and the flowers larger in most aspects. This species also differs from all other members of the group in the inflorescence being an erect, rounded head with the flowers extending beyond the floral bracts.

Notes. Pollinated by birds. Killed by fire, regenerates from seed, normally flowering four years after a fire. Plants continue to grow throughout their lives and long unburnt areas can have very large plants to 2 metres tall by 2 metres wide, unlike *D. oderoides* which is always a small short lived shrub.

Darwinia whicherensis Keighery, *sp. nov.*

Frutex 30–70 cm altus. Folia linearia, triquetra, adulta reflexa, 2–3.5 mm longa. Capitulum terminale, magnum, nutans; bracteae involucri pluri-seriales, exteriores rubrae; bracteae interiores rubrae in centro laminarum, 12–16 mm longae, margine pilosae. Tubus floralis cylindricus, durus, 3–4 mm longus. Lobi calycis minuti, *c.* 1 mm longi. Lobi corollae ovati, cremei, *c.* 3 mm longi. Stylus curvatus, 10–16 mm longus.

Typus: Whicher Range, Western Australia [precise locality withheld for conservation reasons], 16 October 1995, *N. Gibson* 2375 (*holo*: PERTH 04183606).

Darwinia sp. Williamson (G.J. Keighery 12717), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 361 (2000).

Illustration. Brown *et al.* (1998), p. 136.

An erect or spreading *shrub*, to 70 cm tall, often using other shrubs for support. *Leaves* linear, triangular in section, green, crowded at ends of branches, reflexed on mature branches, 2–3.5 mm long, oil glands not prominent, hairless. *Inflorescence* terminal, nodding or rarely erect in young plants, to 30 mm long, with 22–24 flowers. Floral leaves green, flattened, 2–4 mm long. *Floral bracts* in several rows, upper inflorescence bracts reddish, 12–16 mm long with an expanded base to 3 mm wide, and fringed along the margins. Longest floral bracts linear, red in centre, green on margins, margins with long simple hairs, 22–27 mm long, 2.5–3 mm wide, enclosing the flowers. Inner *inflorescence bracts* similar but green. Each flower base enclosed by two floral bracts, linear, strongly keeled translucent, brown, margins fringed, linear, 8–10 mm long. *Floral tube* brown, ribbed, 3–4 mm long, with 5 ridges. *Calyx lobes* white, translucent, triangular, margins entire, *c.* 1 mm long. *Petals* white, margin entire, *c.* 3 mm long. *Style* curved, 10–16 mm long, red. *Ovules* 2. (Figure 5)

Specimens examined. WESTERN AUSTRALIA: 27 Nov. 1991, *G.J. Keighery* 12717 (PERTH); 16 Oct. 1992, *B.J. Keighery & N. Gibson s.n.* (PERTH).

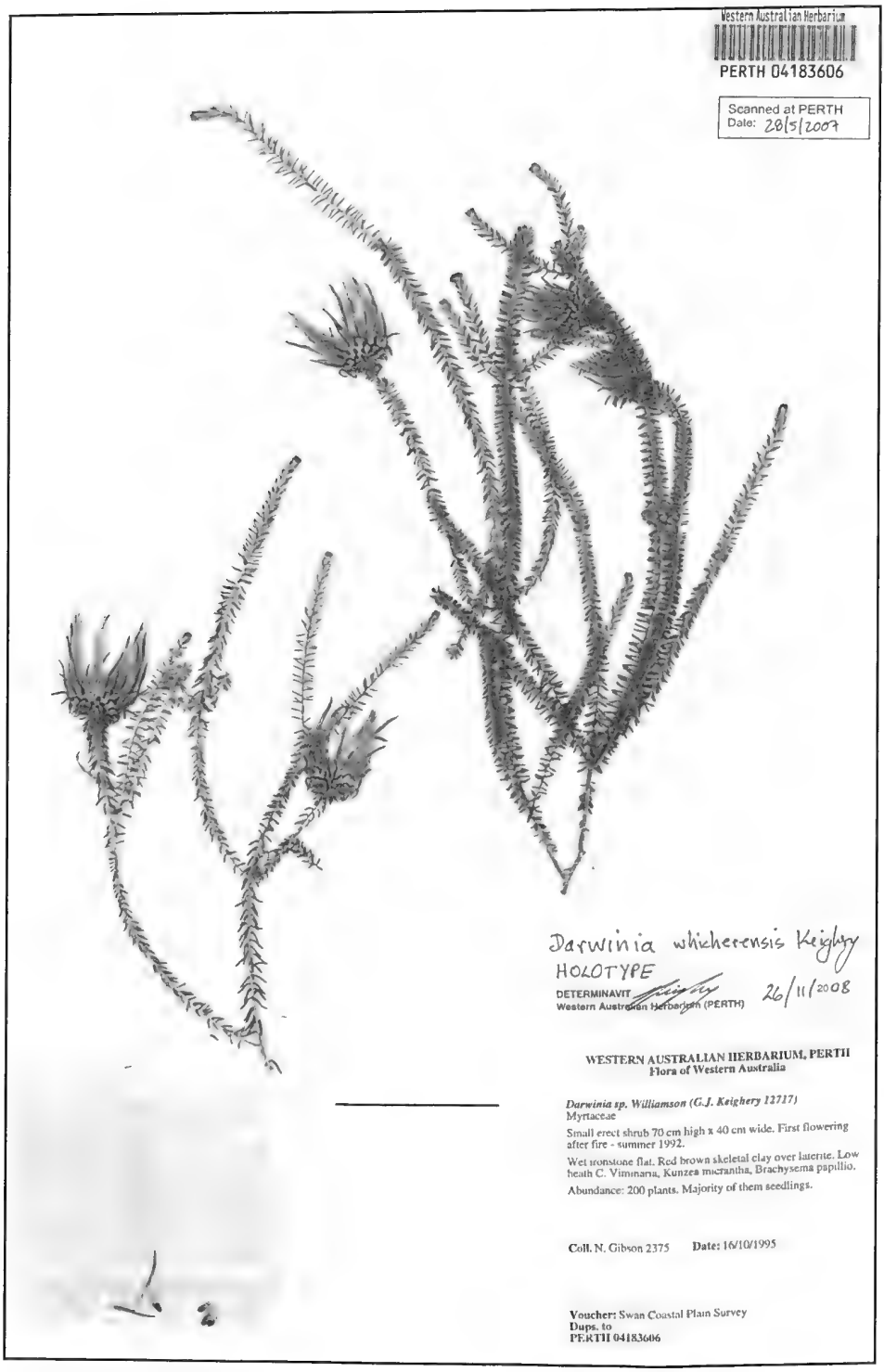

Figure 5. Holotype of *Darwinia whicherensis*, scale bar = 5 cm.

Distribution. Only known from two populations at the base of the Whicher Scarp, SE of Busselton (Figure 6A).

Habitat. Occurs on shallow, red, sandy clay over ironstone, in winter-wet flats under a tall shrubland of *Dryandra squarrosa*. This Critically Endangered ecological community is almost totally cleared and is affected by hydrological change through mining and dieback infection.

Phenology. Flowers in late spring, October to November, finishing in early December.

Conservation status. Listed as Declared Rare Flora under the Western Australian *Wildlife Conservation Act 1950* with a ranking of Critically Endangered as *Darwinia* sp. Williamson (G.J. Keighery 12717) (Atkins 2008).

Etymology. This species is confined to one population at the base of the Whicher Escarpment, south-east of Busselton and is named after this geomorphic feature.

Common name. Abba Bell.

Affinties. Part of the *Darwinia oederoides* group (see previous species). Morphologically related to *D. oederoides* (Bentham 1865) and *D. apiculata*. These species are all small shrubs, killed by fire, bird pollinated, with small, dull red or green bracted rounded inflorescences that are found mainly in the Jarrah Forest Bioregion. It differs from *D. oederoides* in the reflexed leaves, larger (containing more flowers), pendulous inflorescence and its erect habit. Easily differentiated from *D. apiculata* in the blunt reflexed leaves and long fringed bracts around the inflorescence.

Notes. Killed by fire, regenerates from seed. Flowers two years after fire, abundant for 3–4 years after fire then declines to be almost absent 7–10 years post fire.

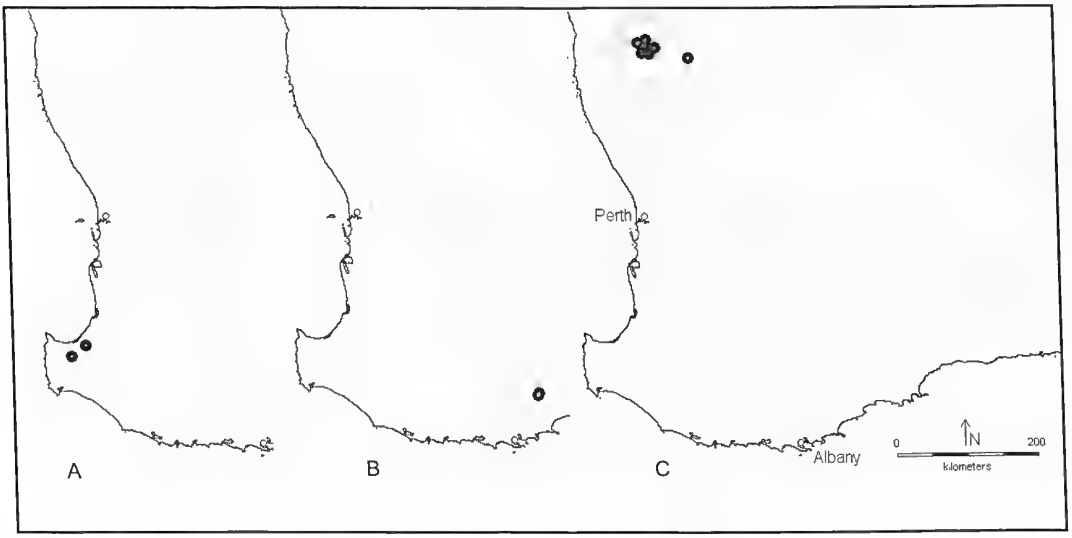

Figure 6. Distribution of *Darwinia* in Western Australia. A – *D. whicherensis*; B – *D. nubigena*; C – *D. polychroma*.

Darwinia nubigena Keighery, *sp. nov.*

Frutex 40–80 cm altus. Folia ovato-elliptica, 4–6 mm longa, 2–3.3 mm lata, margine cilato, apice obtuso. Capitulum terminale, nutans; bracteae exteriores pluri-seriales, rubrae, 15 mm longae, ad marginen fimbriato-denticulatae. Stylus curvatus, cremeus, 15–16 mm longus.

Typus: Stirling Range National Park, Western Australia [precise locality withheld for conservation reasons], 8 December 1997, *E.J. Hickman* 24 (*holo*: PERTH 05734320).

Darwinia sp. Stirling Range (G.J. Keighery 5732), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 361 (2000).

Darwinia sp. Mt. Success (G.J. Keighery 2299), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 361 (2000).

Illustrations. Keighery (1985), p. 4.

An erect *shrub,* 40 to 80 cm tall, often using other shrubs for support. *Leaves* ovate-elliptic in outline, green but paler underneath, scattered, opposite and not crowded, 4–6 mm long, 2–3.3 mm wide, oil glands not prominent, margins fimbriate to ciliate-denticulate, margin slightly recurved, apex obtuse. *Inflorescence* nodding, slender and tubular, to 20 mm long with 4 or 5 flowers. Upper *inflorescence bracts* green, leaf-like at apex of inflorescence, to 4 mm long with an expanded base, to 2 mm wide, fringed along the margins, apex recurved. *Bracts* in 3 rows, longest oblong-elliptic, red, margins fimbriate, 15 mm long, 6 mm wide, apex recurved, acute, exposing the styles. Inner inflorescence bracts similar, 5.5 mm long by 4 mm wide, red with a green tip. Each flower base enclosed by two *floral bracts*, oblong to narrow-elliptic, translucent, brown, margins entire, 6–7.5 mm long. *Floral tube* cylindric-turbinate, brown, ribbed when dry, 4.5–5.5 mm long. *Calyx lobes* white, translucent, triangular, margins fimbriate, *c.* 0.3 mm long. *Petals* red, margins deticulate, 2.4–3 mm long. *Style* curved, 15–16 mm long, pale creamy yellow. *Ovules* 2. (Figure 7)

Specimens examined. WESTERN AUSTRALIA: 5 May 1979, *G.J. Keighery* 2299 (PERTH); 19 Oct. 1982, *G.J. Keighery* 5732 (PERTH); 22 Sep. 1993, *C.J. Robinson* 1165 (PERTH).

Distribution. Endemic to the Stirling Ranges National Park (Figure 6B).

Habitat. Upper valleys and ridgelines over 800 m altitude. Shallow humic black peaty sands over metamorphosed sandstone. Mallee Jarrah over dense montane shrubland.

Phenology. Flowers in spring (September to November).

Conservation status. Listed as Declared Rare Flora under the Western Australian *Wildlife Conservation Act 1950* with a ranking of Endangered as *Darwinia* sp. Stirling Range (G.J. Keighery 5732) (Atkins 2008).

Etymology. From the Latin, meaning born of the clouds.

Common name. Success Bell.

Figure 7. Holotype of *Darwinia nubigena*, scale = 5 cm.

Affinities. Part of a large complex of erect shrubs with large showy inflorescences confined to the Stirling Ranges, known as the Mountain Bells (aspects of their distribution, biology and relationships are detailed in Keighery (1985) and Keighery and Marchant (1993). Most closely related to *D. squarrosa* which occurs on the adjacent Bluff Knoll plateau, with which it shares the same leaf morphology and the small inflorescences with fringed bracts. It differs in the small narrow flower heads, normally with only 4 flowers compared to 6–8 and the red inflorescence bracts which are recurved to expose the cream styles of the flowers.

Notes. Pollinated by birds, killed by fire and regenerates from seed. A band of hybrids between this species and *Darwinia leiostyla* (which grows adjacent to this species under *Eucalyptus talyuberlup*/*E. marginata* mixed mallee) is found on Mount Success (*G.J. Keighery* 5731). Details of these hybrids are discussed and illustrated in Keighery (1985).

Darwinia polychroma Keighery, *sp. nov.*

Frutex 120 cm altus et 150 cm latus. Folia linearia, triquetra, pilifera, ad apicem, aggregata cinerascentia, 2–3 mm longa, acuta, ad marginen ciliata. Capitulum terminale, bracteae involucri pluri-seriales, 4–7 mm longae, rubro-luteae, marginibus pilis longiusculis instructis. Stylus erectus vel curvatus, 8–10 mm longus.

Typus: Near Carnamah, Western Australia [precise locality withheld for conservation reasons], 21 August 1995, *D. Papenfus* DP 113 (*holo*: PERTH 06267599; *iso*: CANB).

Darwinia sp. Carnamah (J. Coleby-Williams 148), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.*: *Descr. Cat.* p. 361 (2000).

Illustration. Brown *et al.* (1998), p. 79.

Erect when young, but becoming a low spreading *shrub* to 1.2 m tall by 1.5 m wide when mature, with numerous old grey woody stems spread along ground. Young stems slender, brown, with prominent decurrent leaf bases. *Leaves* densely packed on ends of branches, leafless on main stems, erect, closely appressed to the branch, linear-triquetrous in section, hairless, green, 2–3 mm long, petiole *c.* 0.5 mm long, oil glands prominent, margin sparsely denticulate. *Inflorescence* nutant, surrounded by shiny yellow-green, green and red coloured bracts in several overlapping rows with margins denticulate-ciliate, leaf like at base. Basal bracts red with a green tip, expanded at base, 6–7 mm long. Second layer yellow to yellow-green, red with an acute, green tip, 10–11 mm long and 4–5 mm wide. Inner bracts base yellow then green then red, 10–12 mm long. Each flower subtended by two floral bracteoles, cymbiform, ovate when spread, scarious, 6 mm long, 2 mm wide, acuminate. *Floral tube* obconical, yellow-green, 3 mm long. *Calyx lobes* narrowly ovate-triangular, *c.* 1 mm long. Petals trullate-obovate, 2–3 mm long, acute, margins enire and slightly involute. *Stamens* 10. *Staminodes* 10. *Style* reddish, slightly incurved at apex, end tapering to apex which is subtended by a sparse ring of hairs, 7–9 mm long. *Ovules* 2. (Figure 8)

Selected specimens examined. WESTERN AUSTRALIA: 8 Oct. 1982, *J. Coleby-Williams* 148 (PERTH); 4 Nov. 1992, *R.J. Cranfield & P.J. Spencer* 8380 (PERTH); 30 July 1996, *E. Holland* 1108 (PERTH); 22 July 1997, *R. Wolstenholme* 10 (PERTH).

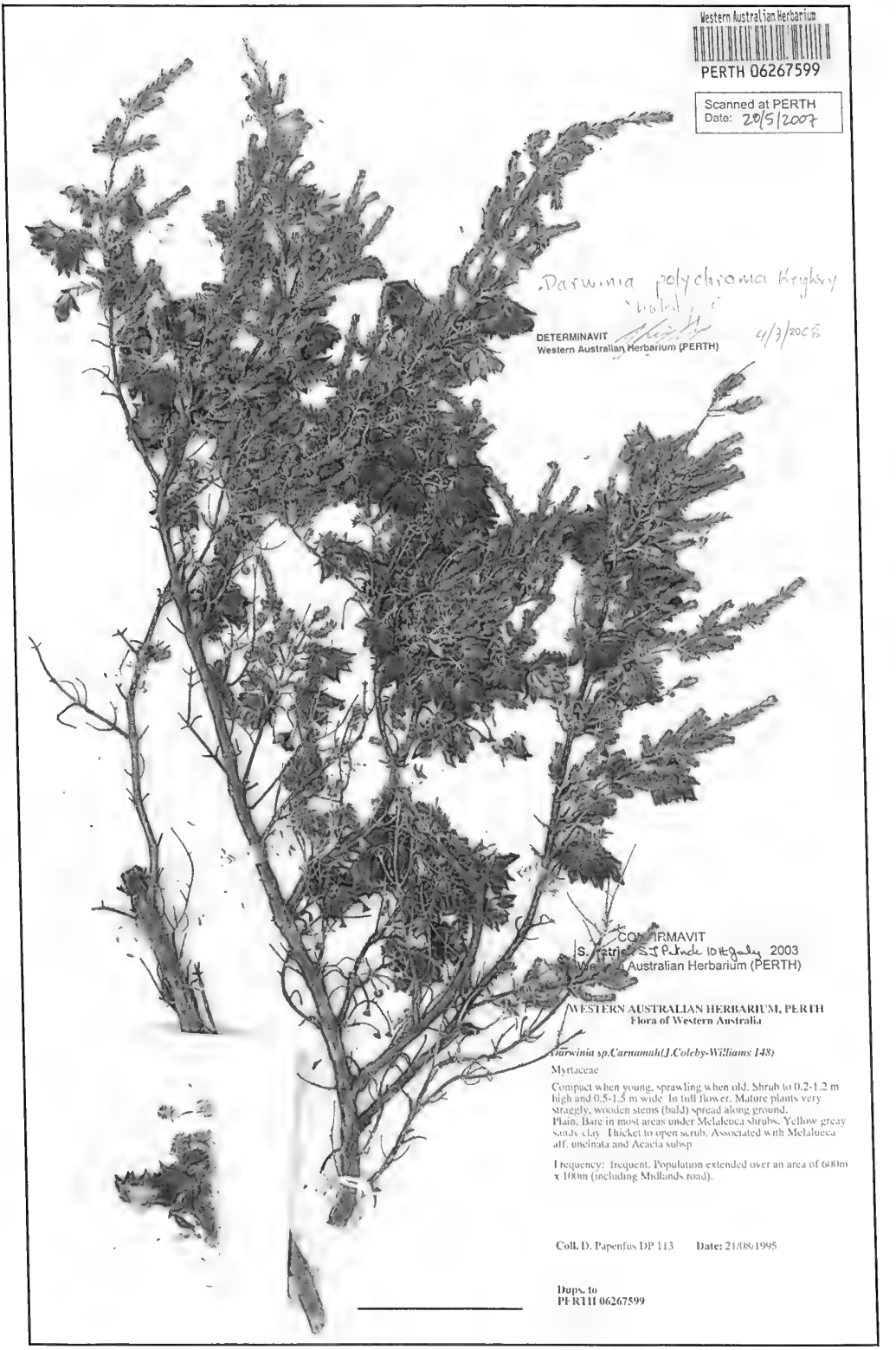

Figure 8. Holotype of *Darwinia polychroma*, scale = 5 cm.

Distribution. Because of past clearing for agriculture, since intensive settlement commencing in 1929, this species is now confined mainly to a few road and rail verges in the Carnamah area (Figure 6C).

Habitat. Usually found on grey, yellow or brown sandy loam over granite or rarely laterite under *Melaleuca* (*M. uncinata sens. lat.*, *M. radula* or *M. sclerophylla*) shrublands, rarely under Tammar (*Allocasuarina campestris*) or mallee shrubland.

Phenology. Flowers in winter and spring, July to September, with a few flowers extending to November.

Conservation status. Listed as Declared Rare Flora under the Western Australian *Wildlife Conservation Act 1950* with a ranking of Endangered as *Darwinia* sp. Carnamah (J. Coleby-Williams 148) (Atkins 2008).

Etymology. From the Greek, meaning many colours: a reference to the bright multi-hued inflorescence bracts, which are pale yellow, green and red.

Common name. Harlequin Bell.

Affinities. Part of a group of four species from the Geraldton Sandplains and NE Avon–Wheatbelt Bioregions which have a spreading habit, long lived but killed by fire, bird pollinated with small nodding inflorescences, usually with numerous flowers with the short styles exceeding the inflorescence bracts. Related to *D. purpurea* differing in the pendant red-green, bell-like inflorescences, with the bracts exceeding and enclosing the flowers and partly the styles.

Notes. Killed by fire, regenerates from seed.

Acknowledgements

This paper was facilitated by the Department of Environment and Conservation's *Saving Our Species* initiative. The reviewer is thanked for correcting the Latin.

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New taxa of *Ptilotus* (Amaranthaceae) from Western Australia

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Abstract

Lally, T.R. New taxa of *Ptilotus* (Amaranthaceae) from Western Australia. *Nuytsia* 19(1): 53–62 (2009). Two new species, *Ptilotus daphne* Lally and *P. rigidus* Lally, and a new subspecies of *P. polakii,* subsp. *juxtus* Lally are described, with distribution maps and illustrations provided.

Introduction

In the course of a revision of the *Ptilotus parvifolius* (F.Muell.) F.Muell. complex (Lally 2008), two putative new taxa with affinities to *P. beardii* Benl and *P. lazaridis* Benl were identified. Specimens which are here referred to as *Ptilotus rigidus* Lally had previously been included in *P. parvifolius* var. *laetus* Benl, while those here described as *P. daphne* Lally were generally regarded as *P. parvifolius* var. *laetus* or *P. lazaridis*. Both *P. daphne* and *P. rigidus* are low, compact shrubs with stiff branchlets and small leaves, features shared with members of the *P. parvifolius* complex. However, floral morphology, especially of *P. daphne*, align these taxa with *P. beardii* and *P. lazaridis*, two species also occurring in Western Australia.

Ptilotus polakii F.Muell., although not readily confused with any members of the *P. parvifolius* complex, is nevertheless related, and also shares some features with the above two new species. When comparing these new species with *P. polakii sens. str.*, it became apparent that more than one entity was currently included within *P. polakii*. One is described here as a subspecies of *P. polakii*, while the other was found to be more closely related to the *P. drummondii* (Moq.) F.Muell. - *P. schwartzii* Tate complex, and will be the subject of a future paper.

Materials and methods

This study is based on examination of herbarium collections from AD, CANB, MEL, NSW and PERTH. All measurements were made from herbarium material (reconstituted where necessary).

Terminology used here to describe the hairs follows that of Benl (1971), as translated by Burbidge (1972). The hairs are basically of the same type (simple) but vary in the degree to which lateral projections are produced at the septa between the primary cells.

In many *Ptilotus* species the tepals are typically greenish and herbaceous, surrounded by a marginal band of scarious tissue of varying width, including the apical portion. For the purposes of this study, length of the apical portion of the tepal is the distance from the end of the herbaceous portion to the apex of the tepal. Width of the apical portion is measured at the mid-point of the scarious apical portion. Width of the scarious marginal band is measured at its widest extent on the tepal.

Taxonomy

Ptilotus daphne Lally, *sp. nov.*

Affinis *P. beardii* Benl, sed foliis basibus induratis deliquis, ovario dense hirto et cupula staminali dense capillis staminodis fere obscurans, differt.

Typus: Blue Hills Station (abandoned), S of boundary of proposed Carnarvon Range Conservation Park, Little Sandy Desert, Western Australia [precise locality withheld for conservation reasons], 28 August 1999, *D.J. Edinger* Nats 58 (*holo*: PERTH 05442443).

Ptilotus sp. Carnarvon Range (D.J. Edinger Nats 58), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed April 2008].

Shrub to 30 cm high; stems striate, with moderately dense, cobwebby, dendritic or verticillate hairs, older stems glabrescent. *Leaves* sessile to subsessile, without a hardened base, narrowly elliptic or obovate to ovate, 2–5.5 mm long, 0.5–1.5 mm wide, fasciculate, with sparse cobwebby, dendritic or verticillate hairs (denser on young leaves), green, ± fleshy; apex mucronate, mucro to 0.6 mm long. *Inflorescence* a loosely hemispherical spike to 2.5 cm long, rachis to 0.8 cm long, 7–10-flowered. *Bract* 3–4.5 mm long; *bracteoles* 4.8–6 mm long, bract and bracteoles concave with moderately dense, dendritic or verticillate hairs along midrib, both translucent, pale golden-brown; apex and midrib hardened, mucronate, mucro to 0.6 mm long. *Perianth* 15–19 mm long, purple. *Tepals* linear, curving outwards at the apex; herbaceous with a very narrow (*c.* 1 mm wide) scarious marginal band and apical portion; outer surface with short (to 0.8 mm), moderately dense, simple hairs at base, dense, verticillate or subverticillate hairs on remainder, with sparse, longer (to 4 mm), nodose hairs over-topping these in the upper half of tepals; glabrous apical portion 2–2.5 mm long, apex erose, obtuse to truncate; outer tepals longer than two of the inner by 1–2 mm, glabrous inside; inner tepals with moderately dense, crisped, nodose hairs inside, attached to the margins in the lower quarter. Fertile *stamens* 2, 8.5–10 mm long, glabrous; *staminodes* 3, to 0.6 mm long, obscured by dense, nodose hairs to 1 mm long on the staminal cup. *Anthers* 0.8–0.9 mm long. *Ovary* covered with dense, verticillate hairs; *style* eccentric, sinuate or straight, 9–9.5 mm long, with a few verticillate hairs in lower third. (Figure 1)

Other specimens examined. WESTERN AUSTRALIA: Carnarvon Range [precise locality withheld for conservation reasons], 26 Aug. 1999, *M.Hancock* 1103 (PERTH).

Distribution and habitat. Apparently restricted to the Carnarvon Range, *c.* 160 km NNE of Wiluna in the Keartland Botanical District (Figure 2). Growing on a stony quartzite ridge. Associated vegetation not indicated.

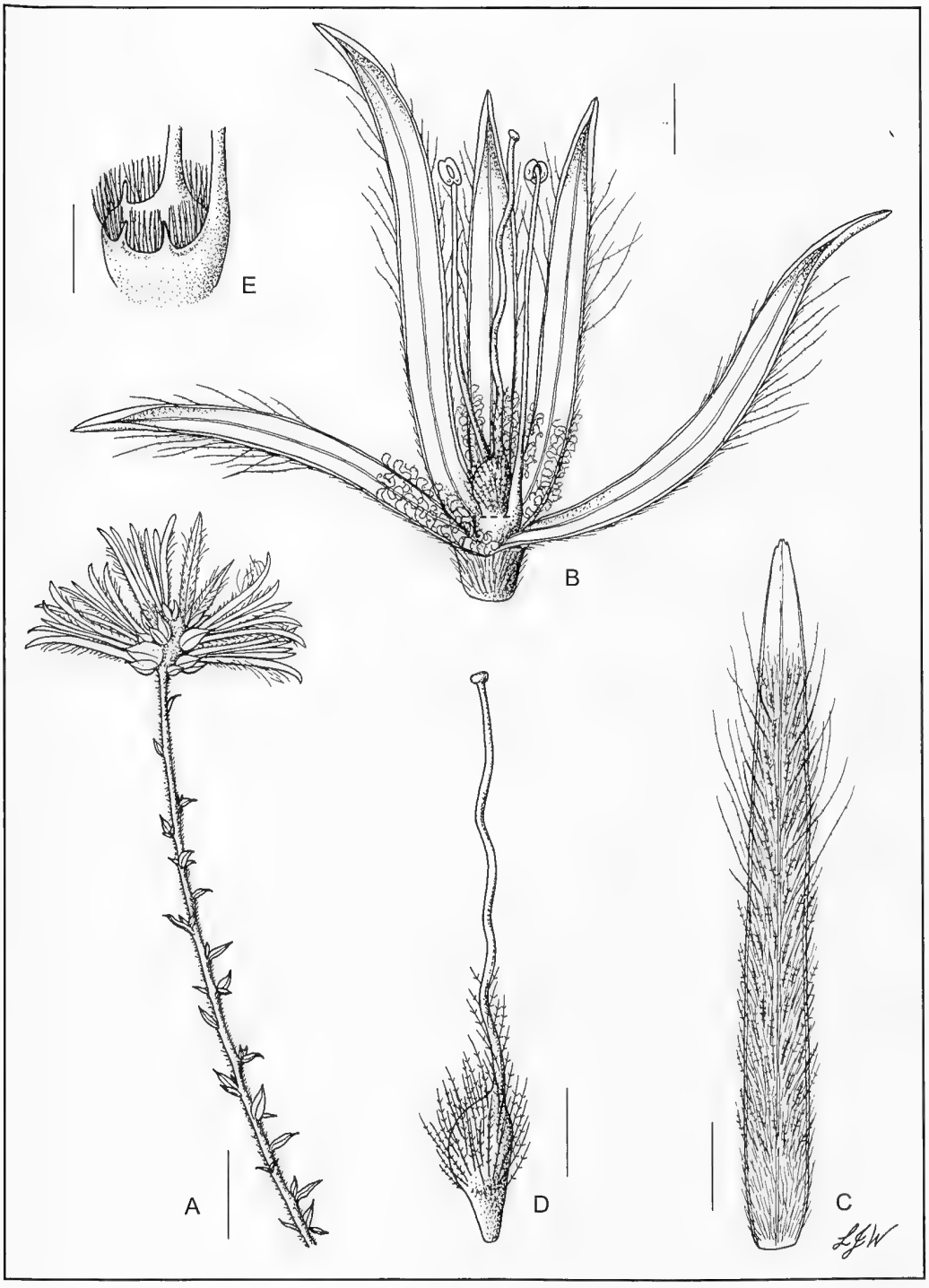

Figure 1. *Ptilotus daphne*. A – portion of branchlet with inflorescence; B – flower (perianth), opened out; C – outer surface of outer tepal; D – ovary and style; E – staminal cup. Drawn from *D.J. Edinger* Nats 58 (A), *M. Hancock* 1103 (B–E). Scale = 30 mm (A); 2 mm (B–E).

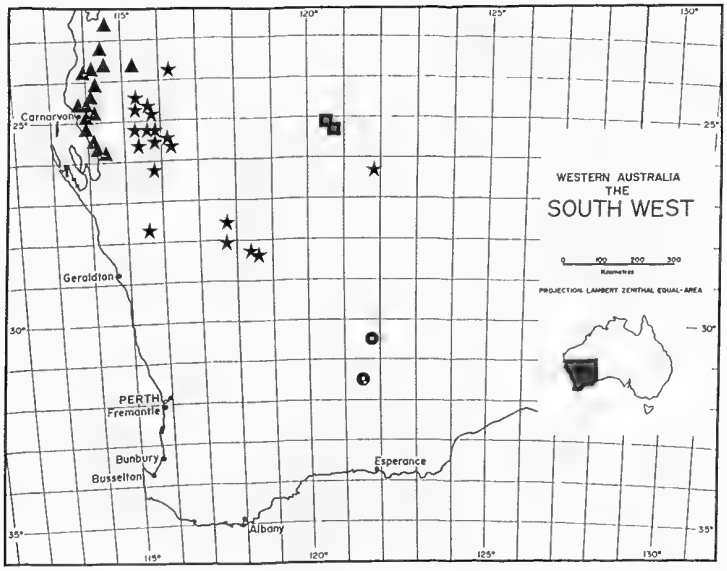

Figure 2. Distribution of *Ptilotus daphne* (■), *P. polakii* subsp. *juxtus* (▲), *P. polakii* subsp. *polakii* (★) and *P. rigidus* (●) in Western Australia.

Conservation status. As this species is only known from two populations on unreserved land, just outside the proposed Carnarvon Range Conservation Park, Western Australia, it was recently listed as Priority One, under *Ptilotus* sp. Carnarvon Range (D.J. Edinger Nats 58), according to the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora.

Etymology. Named for Ms Daphne Edinger, a volunteer at the Western Australian Herbarium, Perth. Daphne has contributed many useful and interesting collections from across Western Australia, often from remote localities, including the type material of this taxon.

Notes. This species is closely related to *P. beardii*, sharing long, linear tepals which curve outwards at the apex when mature and a similar habit, a compact shrub with terminal inflorescences, borne on new growth. It differs from *P. beardii* in its green leaves without a hardened base (grey-green with a hardened, yellowish, decurrent base in *P. beardii*), perianth with long, over-topping nodose hairs in the upper part of the tepal only (long, over-topping nodose hairs all over the tepals in *P. beardii*), densely hairy ovary and partially hairy style (both glabrous in *P. beardii*), inner tepal hairs moderately dense and woolly (very dense and intertwined in *P. beardii*) and dense ring of hairs on the staminal cup with short, barely visible staminodes obscured by hairs (hairs only present between filaments, staminodes longer and more obvious in *P. beardii*).

The floral morphology of *P. daphne* is similar to *P. lazaridis* in the long, linear tepals, the outer tepals with long, over-topping nodose hairs in the upper half only, and the hairy ovary. *Ptilotus daphne* differs by having inner tepals with moderately dense, crisped hairs (sparse straight hairs in *P. lazaridis*), staminodes to 0.6 mm (2–2.2 mm in *P. lazaridis*) and ovary densely hairy all over (hairy in upper part only in *P. lazaridis*). In habit, *P. daphne* is quite different, being a hairy, compact shrub, with small, elliptic or obovate leaves, whereas *P. lazaridis* is a glabrous, more open, divaricate shrub with larger, elliptic leaves.

Specimens of this species have previously been determined as *P. parvifolius* var. *laetus* (now *P. remotiflorus* Benl) which it superficially resembles due to its compact habit, stiff branchlets and small leaves. However *P. daphne* differs in its shortly racemose inflorescences to 0.8 cm long, with flowers 15–19 mm long (*P. remotiflorus* has racemes 1–6 cm long, with flowers 9–12 mm long), and tepals being more or less flat, linear and lacking a broad marginal band (*P. remotiflorus* has concave, oblong tepals with a broad marginal band).

Ptilotus rigidus Lally, *sp. nov.*

Affinis *P. beardii* Benl et *P. daphne* Lally, sed floribus minoribus et caulibus glabris, differt. Quoque affinis *P. parvifolio* (F.Muell.) F.Muell. et *P. remotifloro* Benl, sed marginibus scariosis tepalorum deliquis et pilis tepalorum exteriorum ad dimidium inferius limitatis, differt.

Typus: Lake Lefroy, Western Australia, 22 November 1995, *G. Barrett* 716 (*holo*: PERTH 04308425).

Ptilotus sp. Lake Lefroy (G. Barrett 716), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed April 2008].

Rigid, subspinescent *shrub* to 25 cm high; stems striate, glabrous, the new stems green. *Leaves* sessile to subsessile, narrowly obovate, 2.5–5.5 mm long, 0.5–1 mm wide, fasciculate, with very sparse, ± crisped, multi-cellular hairs, glabrescent, dark green, fleshy; apex mucronate, mucro to 0.5 mm long. *Inflorescence* an oblong or loosely hemispherical spike to 3 cm long, rachis to 2 cm long, 12–40-flowered. *Bract* 4.5–5.2 mm long; *bracteoles* 5.5–6 mm long, bract and bracteoles deeply concave with moderately dense, verticillate or subverticillate hairs on upper surface, denser at base and along midrib, both translucent, cream to pale golden-brown; apex and midrib hardened, mucronate, mucro to 1.2 mm long. *Perianth* 11–13 mm long, possibly pink. *Tepals* linear or narrowly oblong; herbaceous with a very narrow (*c.* 1 mm wide) scarious marginal band and apical portion; outer surface with short (to 1 mm), moderately dense, nodose or subverticillate hairs at base, dense, short, verticillate hairs on remainder, with sparse longer (to 2.2 mm), nodose hairs over-topping these, mainly in lower half of tepals only; glabrous apical portion 3–4 mm long, apex acute or obtuse; outer tepals longer than inner by *c.* 1 mm, glabrous inside; inner tepals with dense, crisped, nodose hairs inside, attached to the margins of the tepals in the lower quarter. Fertile *stamens* 2, 6–7 mm long, with soft, crisped, nodose hairs on lower third; *staminodes* 3, to 0.6 mm long, obscured among the dense, nodose or subverticillate hairs to 0.6 mm long between the filaments of the staminal cup. *Anthers* 0.9–1.4 mm long. *Ovary* with moderately dense, nodose or subverticillate hairs at apex and along sutures adjacent and opposite style; *style* eccentric, straight or slightly sinuate, 7–8 mm long, with scattered, verticillate hairs along its length. (Figure 3)

Other specimens examined. WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] between Coolgardie and Norseman, 27 Mar. 1968, *S.G.M. Carr* 589 (AD, PERTH); SW of Jubilee, 30 Mar. 1962, *Forests Dept., Kalgoorlie* 1755/62 (PERTH).

Distribution and habitat. Occurs within an area 100 km north-east, and south, of Kalgoorlie, between Jubilee and just south of Widgiemooltha (Figure 2). Associated with salt lakes, vegetation not indicated.

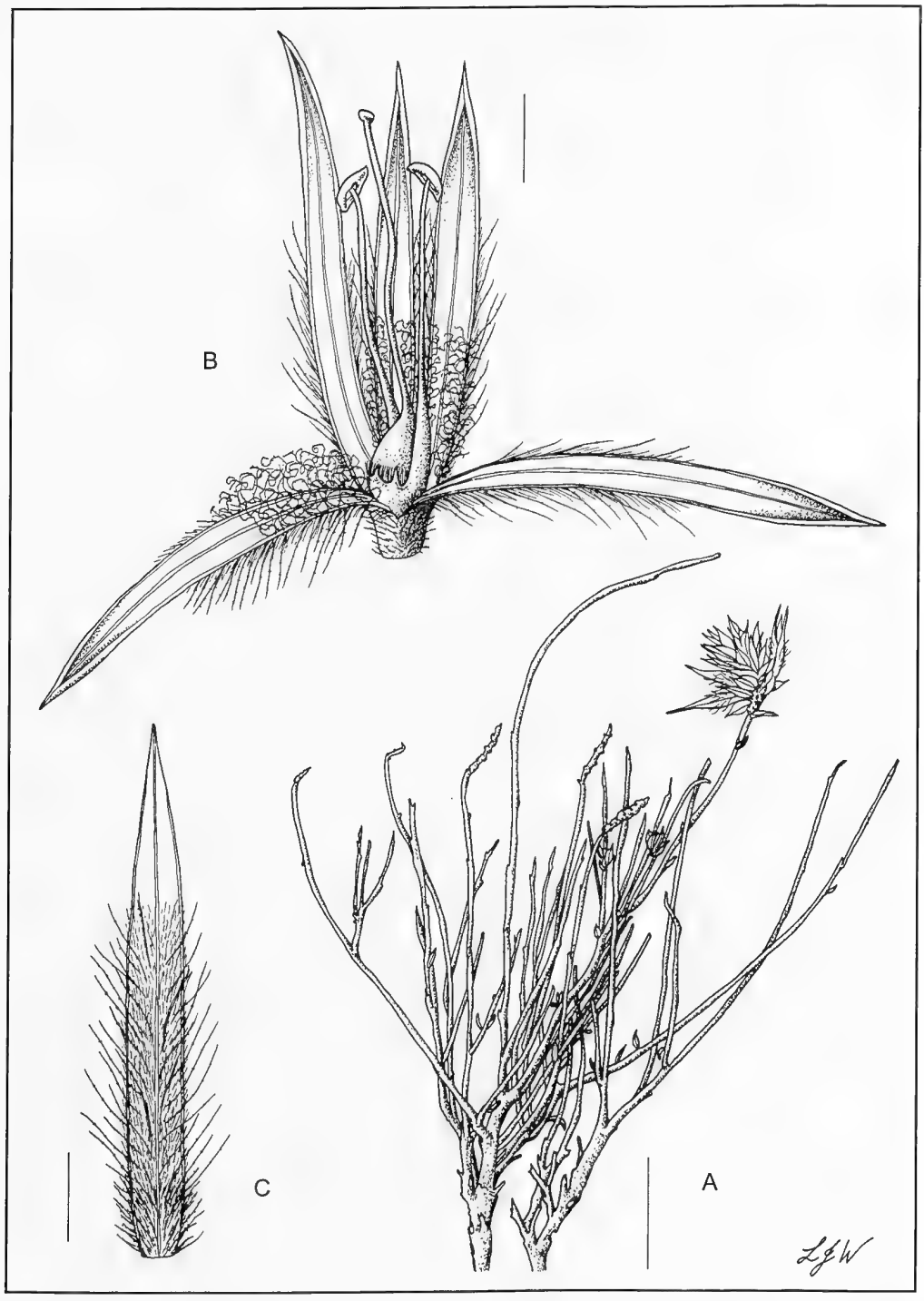

Figure 3. *Ptilotus rigidus*. A – habit; B – flower (perianth), opened out; C – outer surface of outer tepal. Drawn from *S.G.M. Carr* 589. Scale = 20 mm (A); 2 mm (B, C).

Conservation status. As this species is only known from three collections, two from the 1960s and one more recent gathering from 1995, it was recently listed as Priority One, under *Ptilotus* sp. Lake Lefroy (G. Barrett 716), according to the DEC Conservation Codes for Western Australian Flora. Survey work is required to determine if the older populations are still extant, and whether further populations exist, associated with the numerous salt lakes in the area.

Etymology. The epithet is from the Latin *rigidus* (rigid, unbendable), referring to the stiff, stick-like habit of this species.

Notes. Benl (1986) included specimens of *P. rigidus* in his concept of *P. parvifolius* var. *laetus sens. lat*. Superficially this species could be confused with taxa in the *P. parvifolius* complex (especially *P. parvifolius* and *P. remotiflorus*) due to the subspinescent, leafless habit and similarly sized flowers. However, *P. rigidus* can be distinguished by its more or less flat, linear tepals lacking a broad marginal band (*P. parvifolius* and relatives have concave, oblong tepals with a broad marginal band), and sparse, long hairs on the outer tepals confined to the lower half (hairs on the outer tepals of *P. parvifolius* and *P. remotiflorus* are denser and extend to near the glabrous apical portion).

Ptilotus rigidus is closer to *P. beardii* and *P. daphne*, sharing similar floral morphology (linear tepals with a very narrow marginal band and large, glabrous apical portion). The fleshy leaves and barely visible staminodes obscured by short staminal cup hairs are features it shares with *P. daphne*. *Ptilotus rigidus* differs from *P. daphne* in its smaller flowers, 11–13 mm long (15–19 mm long in *P. daphne*), glabrous stems (cobwebby hairy in *P. daphne*), over-topping nodose hairs on the outer tepals longer in the lower half (longer in the upper half in *P. daphne*) and the partially hairy ovary (ovary hairy all over in *P. daphne*). *Ptilotus rigidus* can easily be distinguished from *P. beardii* by its shorter flowers, 11–13 mm long (15–17 mm long in *P. beardii*), glabrous stems and leaves (hairy in *P. beardii*) and barely visible staminodes (longer and more obvious in *P. beardii*).

Ptilotus polakii F.Muell., *Southern Science Record* 274 (1882).

Trichinium polakii (F.Muell.) Diels in F.L.E. Diels & E. Pritzel, *Bot. Jahrb. Syst.* 35: 191 (1904). *Type*: 'In the vicinity of the Gascoyne River', *Polak s.n.* (*holo*: MEL 2279187; *iso*: MEL 59257, MEL 2279188).

Ptilotus depressus W. Fitzg., *J. Western Australia Nat. Hist. Soc.* 1: 33 (1904); *Trichinium depressum* (W. Fitzg.) Farmar, *Bull. Herb. Boissier*, ser. 2, 5: 1087 (1905). *Type*: Lennonville, W.A., Sept. 1903, *W.V. Fitzgerald s.n.* (*holo*: PERTH 00305006; *iso*: M *n.v.*, NSW 29851, NSW 638132, NSW 676127).

Shrub 0.2–1 m high, 0.3–1.2(–2) m wide; stems striate, with sparse, weak, simple or verticillate hairs, denser on new shoots, new stems green, older grey-brown or grey-black, glabrous or glabrescent. *Leaves* shortly petiolate, petiole 0.5–1(–5) mm long, narrowly elliptic or narrowly to broadly obovate to ± spathulate, (4–)6–17(–28) mm long, 1.5–7(–10) mm wide, sometimes clustered at new stem shoots, glabrous or with sparse, often cobwebby hairs, or sometimes with minute simple or verticillate white hairs (denser on young leaves), grey-green, dull green or green; apex mucronate or acute, mucro to 0.5 mm long. *Inflorescence* a globose, hemispherical or oblong spike to 3.5 cm long, rachis to 2.5 cm long, 6–30-flowered. *Bract* (1.8–)2.5–6(–7) mm long, concave, with sparse to moderately dense, verticillate hairs mainly at base, or glabrescent or glabrous, translucent, pale golden-brown; apex acute; *bracteoles* (2.5–)3.8–6(–8) mm long, concave, with sparse to moderately dense, verticillate

hairs, mainly along midrib or apex, or glabrescent or glabrous, translucent, pale golden-brown; apex apiculate. *Perianth* 8–16(–18) mm long, pink, purple or white-cream. *Tepals* linear, shallowly concave; herbaceous with a very narrow (*c.* 0.2 mm wide) scarious marginal band and apical portion; outer surface with short (to 0.8 mm), moderately dense, nodose or subverticillate hairs at base, dense, verticillate or subverticillate hairs on remainder, with sparse, longer (to 5 mm), nodose or subverticillate hairs over-topping these, denser and longer on lower part of tepal; glabrous apical portion of outer tepals 0.5–5(–5.5) mm long, 0.5–1.6(–1.8) mm wide, apex ± erose, obtuse to truncate; outer tepals longer than two of the inner by 1–2 mm, glabrous inside; inner tepals with dense, crisped, nodose hairs inside, attached to the margins in the lower third, the hairs extending to half, or just near half, the tepal length; glabrous apical portion of inner tepals 0.5–3 mm long mm long, apex ± erose, obtuse to truncate. Fertile *stamens* 2, 4–7.5(–9) mm long, glabrous; *staminodes* 3, 0.5–1.8 mm long, obscured among the dense, nodose hairs to 1.1 mm long on the staminal cup. *Anthers* 0.5–1.2 mm long. *Ovary* glabrous; *style* eccentric, sinuate or straight, 4–9(–10.5) mm long.

Two subspecies are recognised.

1. Glabrous apical portion of outer tepals 3–5(–5.5) mm long and 1–1.6(–1.8) mm wide; bract usually ± equal in length to bracteole; inland, Gascoyne Junction to Cue ..... subsp. **polakii**
1: Glabrous apical portion of outer tepals 1–2 mm long and <1 mm wide; bract shorter than bracteole; coastal, S of Onslow to Overlander Roadhouse ..... subsp. **juxtus**

Ptilotus polakii F.Muell. subsp. **polakii**

Illustration. Moore (2005: 259).

Shrub 0.2–0.9 m high, 0.3–1.2 m wide. *Leaves* (5–)6–11(–15) mm long, 1.5–4.2 mm wide, usually with sparse, often cobwebby, simple or verticillate white hairs (denser and more visible on young leaves), or glabrescent or glabrous. *Bract* usually ± equal to bracteole, 4–6(–7) mm long; *bracteoles* 3.8–6(–8) mm long. *Perianth* 10–16(–18) mm long. Outer *tepal* glabrous apical portion 3–5(–5.5) mm long and 1–1.6(–1.8) mm wide, inner tepal glabrous apical portion 2–3 mm long. *Stamens* 6–7.5(–9) mm long. *Style* 6–9(–10.5) mm long.

Selected specimens examined. WESTERN AUSTRALIA: 9 km W of Jimba Jimba homestead, 7 May 1995, *R.J. Cranfield* 9706 (CANB, PERTH); 10 km from Wongawol homestead on the Wiluna road, 7 Sep. 1982, *L.A. Craven* 7519 (CANB); 31 km ESE of Gascoyne Junction, 13 Sep. 1987, *J.W. Green* 5387 (CANB, PERTH); Cue, Oct. 1909, *J.H. Maiden s.n.* (MEL, NSW); 21 km NW of Mt Sandiman, 21 Aug. 1987, *K.R. Newbey* 11667 (PERTH); Windimurra Station, 60 km E of Mount Magnet, 24 Sep. 1998, *P. van der Moezel & S. Maxwell* 010 (PERTH); *c.* 38 km E of Coolcalalaya Station homestead on road to Yallalong Station and ca 50 metres S of road, 16 Sep. 2004, *F. Obbens & F. Hort* FO 52/04 (CANB, MEL, PERTH); Mullewa-Mount Augustus Road at 110 km S of Cobra homestead, 8 Aug. 2000, *S. Patrick & A. Cochrane* SP 3504 (CANB, PERTH); Glenburgh Station, Carnarvon–Mullewa Road, at 31 km SE of turnoff to Dairy Creek homestead, 10 Aug. 2000, *S. Patrick & A. Cochrane* SP 3545 (PERTH); 8 miles SW of Dalgety, *s. dat.*, *N.H. Speck* 1505 (CANB, PERTH); 39 km N of Lyons River homestead, 27 Sep. 1979, *H.R. Toelken* 6410 (AD); Mt Warren, 1893, *I. Tyson s.n.* (MEL); Near Gascoyne Junction, Kennedy Range National Park near campground, 26 July 2002, *J.E. Wajon* 539 (PERTH); at base of Mt Magnet, 14 Oct. 1981, *J.G. West* 4476 (CANB, PERTH).

Distribution and habitat. This subspecies has its main distribution from the Kennedy Range near Gascoyne Junction in the north, to Coolcalalaya and Yallong Stations (*c.* 100 km E of Kalbarri) in the south, and inland to Wongawal Station, *c.* 180 km E of Wiluna, and the Mt Magnet area. There is also a collection from Mt Warren, near Cosmo Newberry, a further 150 km inland (*I. Tyson s.n.*, 1893) (Figure 2).

Recorded growing in well-drained, red or red-brown sandy loam or clay loam, often in stony sites (including lateritic and quartzic substrates), on plains, foothills or ridges. Occurs in open shrubland of *Acacia* and *Eremophila* with *Maireana*, *Chenopodium*, *Atriplex*, *Grevillea*, *Hakea* and *Gnephosis*.

Notes. This subspecies differs from subsp. *juxtus* in its usually larger flowers with longer and wider, prominent apical portion on the tepals, which are often incurved. It also has the bract usually ± equal to the bracteoles and usually has hairier leaves and stems, the hairs persisting longer on these parts with age.

Ptilotus polakii subsp. **juxtus** Lally, *subsp. nov.*

Affinis subsp. *polakii*, sed floribus minoribus cum brevioribus et angustioribus apicibus tepalorum, differt.

Typus: 43 km E of Carnarvon on road to Gascoyne Junction, Western Australia, 27 September 1987, *P.G. Wilson* 12658 (*holo*: PERTH 02160773 *n.v.*; *iso*: CANB, CBG 9212606).

Illustration. Mitchell & Wilcox (2008: 328–329).

Shrub 0.3–1 m high, 0.4–1(–2) m wide. *Leaves* (4–)9–17(–28) mm long, 3.5–7(–10) mm wide, usually glabrous or with barely visible simple hairs, or younger growth sometimes with simple or verticillate white hairs, becoming glabrous with age. *Bract* usually shorter than bracteole, (1.8–)2.5–4 mm long; *bracteoles* (2.5–)3.8–5 mm long. *Perianth* 8–13 mm long. Outer *tepal* glabrous apical portion 1–2 mm long and <1 mm wide, inner tepal glabrous apical portion 0.5–1 mm long. *Stamens* 4–6 mm long. *Style* 4–5.5 mm long.

Selected specimens examined. WESTERN AUSTRALIA: Approx. 20 km NE of Carnarvon, 16 Oct. 1986, *B. Archer s.n.* (MEL); *c.* 40 km S of Carnarvon, Onslow Road junction, 17 Aug. 1969, *A.M. Ashby* 2958 (AD); Winning Pool repeater station, North West Coastal Highway, 56.2 km S of the Yannarie River, 12 Oct. 2005, *G. Byrne* 1696 (PERTH); Lyndon–Williambury track, E side of Williambury Station, 9 Aug. 1981, *R.J. Cranfield* 1841 (PERTH); Wandagee Station, N of Yalobia Well, west of West Coast Highway, Sep. 1959, *S.J.J. Davies* 6 (PERTH); Boologooro, 1 km NW of homestead, 89 km N of Carnarvon, 13 Oct. 1983, *S.J. Forbes* 1578 (MEL, PERTH); 28 km W of Wahroonga homestead near North West Coastal Highway, 15 Sept. 1987, *J.W. Green* 5416 (CANB, PERTH); *c.* 14 km by road NNE of Minilya Roadhouse (Minilya River crossing) on North West Coastal Highway, 30 Aug. 1977, *E.N.S. Jackson* 3073 (AD, M); 135 mile peg between Onslow–Carnarvon, 26 Oct. 1963, *F. Lullfitz & P. Fairall* 2808 (PERTH); 45 miles S of Carnarvon, *s. dat.*, *N.H. Speck* 765 (PERTH); *c.* 30 km W of Minnie Creek homestead, 30 Sep. 1975, *J.Z. Weber* 4844 (AD, PERTH).

Distribution and habitat. This taxon occurs from near Onslow in the north to Gladstone in the south, and from Carnarvon inland to just beyond the North West Coastal Highway, with its most inland locality west of Minnie Creek Station (Figure 2).

Recorded in red-brown rocky or quartzitic loam, clay or sand, on flats and plains in areas subject to periodic inundation. Associated with *Acacia* and *Eremophila* shrubland with *Triodia* and *Calandrinia*.

Etymology. From the Latin *juxta* (nearby or next to), referring to the geographical proximity of this subspecies, to the typical subspecies.

Notes. This subspecies usually has flowers with a shorter and narrower apical portion on the tepals than the typical subspecies. The bract is usually shorter than the bracteoles, and the leaves and stems are generally glabrous or glabrescent.

Acknowledgements

Thanks are due to Rob Davis for alerting me to the existence of the *P. daphne* specimens at PERTH, Lisa Waters for the illustrations, Laurie Adams for the Latin diagnoses, Anna Monro for assistance with graphics, Brendan Lepschi for encouragement, guidance and helpful comments on the manuscript and to the directors of AD, CANB, MEL, NSW and PERTH for access to specimens in their care.

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Three new species of *Acacia* (Leguminosae: Mimosoideae) from the Kimberley Region, Western Australia

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Abstract

Lewington, M.A. & Maslin, B.R. Three new species of *Acacia* (Leguminosae: Mimosoideae) from the Kimberley Region, Western Australia. *Nuytsia* 19(1): 63–75 (2009). Three new species of *Acacia* Mill. endemic to the Kimberley region of northern Western Australia are described: *Acacia barrettiorum* Lewington & Maslin *sp. nov.*, *A. spectra* Lewington & Maslin *sp. nov.* and *A. willingii* Lewington & Maslin *sp. nov. Acacia willingii* is listed as Priority One and *A. barrettiorum* and *A. spectra* as Priority Two species under the Department of Environment and Conservation's Conservation Codes for Western Australian flora.

Introduction

The remote Kimberley region in far northern Western Australia comprises a diverse and often rugged topography. There are relatively few roads and access to many areas requires the use of boat or helicopter; collecting during the wet summer months (December to February) is particularly difficult and as a consequence there are relatively few gatherings from this time of the year. Restricted access to much of the north-west Kimberley has lead to a marked temporal and geographic sampling bias in existing collections, and it is therefore difficult to estimate the number of undiscovered short-range endemics, especially those associated with rugged sandstone and seasonally-wet habitats. Currently about 130 species of *Acacia* Mill. have been recorded for the Kimberley (Maslin 2001) but judging from the collections at the Western Australian Herbarium (PERTH) there are a number of undescribed wattles in the region, three of which are described below. Two of these species (*A. barrettiorum* and *A. spectra*) were discovered relatively recently (2003 and 1998 respectively), well after the period when several botanical surveys were conducted in the Kimberley (see George & Kenneally 1975 and 1977, Hnatiuk & Kenneally 1981, Kenneally 1983 and McKenzie & Kenneally 1983). Although the third species, *A. willingii*, was first collected in 1921 the species was not able to be properly characterized until collections made in 2006 came to hand.

New species descriptions

Acacia barrettiorum Lewington & Maslin, *sp. nov.*

Frutices glabri. *Phyllodia* congesta, patentia, parvissima (1.5–3 longa, 1–3 mm lata), triangularia ad oblongo-triangularia, indistincte 3–7-nervia; *basis* lata, sessilia; *apex* puncta conspicuosa setosa sursum inflexa 0.5–2 mm longa; *nervi longitudinales* 3–7 per superficiem, indistincti. *Inflorescentiae* simplices, solitariae in axillis phyllodiorum positae; *pedunculi* 4–7 mm longi, bractea basali pedunculari absentia; *capitula* globularia, 30–40-flora. *Bracteolae c.* 2 mm longae, laminis lineari-triangularibus acuminatis. *Flores* 5-meri; *sepala* ±libra. *Legumina* angusto-linearia, 30–60 mm longa, 2–3 mm lata, tenui-textura, resinosa, atro rubro-brunnea, tenuiter longitudinaliter nervosa. *Semina* in legumina longitudinales posita; *arillus* albus.

Typus: Kimberley region, Western Australia [precise locality withheld for conservation reasons], 20 January 2003, *R.L. & M.D. Barrett* 2611 (*holo*: PERTH 07271220; *iso*: CANB, DNA, K, MEL, NSW, NY, PERTH 07687567).

Sprawling to ascending, glabrous *shrubs* 1–2.5 m tall and to *c.* 3.5 m across. *Branchlets* terete, ± ribless, green at extremities aging light brown to reddish brown, sometimes slightly resinous, bearing elongated, narrow, yellow scars where phyllodes have fallen. Tips *of new shoots* echinulate due to numerous conspicuous erect tips of the crowded phyllodes. Stipules mostly caducous, very narrowly triangular, inconspicuous (0.2–0.3 mm long). *Phyllodes* crowded, patent, triangular to oblong-triangular with a broad, sessile, truncate base, 1.5–3 mm long, 1–3 mm wide, slightly longitudinally wrinkled when dry, green, slightly shiny (especially when fresh), stomata visible at x10 magnification; *longitudinal nerves* indistinct, 3–7 per face with the central one slightly more pronounced than the rest; *apices* terminated by a conspicuous, upwardly inflected, subulate, setose, light brown, brittle mucro 0.5–2 mm long. *Gland* absent or inconspicuous on upper margin of phyllode above the middle. *Inflorescences* simple, single within axil of phyllodes; *peduncles* 4–7 mm long, resinous, somewhat stout, often finely and sparingly longitudinally ribbed when dry; *basal peduncular bracts* absent; *heads* globular, 7–9 mm diam. when dry, light golden, 30–40-flowered. *Bracteoles c.* 2 mm long, slightly exserted beyond the flowers in buds; *claws* short (1/4–1/3 length of lamina); *laminae* shallowly inflexed, linear-triangular, acuminate and terminating in a slender, light brown point. *Flowers* 5-merous; *sepals c.* 1/3 length of petals, free or almost so, 0.8–1 mm long, narrowly linear; *petals* 1.7–2 mm long, 1-nerved, sometimes very obscurely striate; *stamens* free. *Pods* narrowly linear, slightly raised over the seeds and not or scarcely constricted between them, 30–60 mm long, 2–3 mm wide, firmly chartaceous to thinly coriaceous, shallowly curved (valves slightly irregularly twisted after dehiscence), resinous, slightly viscid, dark red-brown, longitudinally finely nerved with some sparingly anastomosing, marginal nerve slightly thickened. *Seeds* longitudinal in the pods, obloid, 3–4 mm long, 1.8–2 mm wide, compressed (*c.* 2 mm thick), ± shiny, black; *pleurogram* continuous, bordered by a narrow band of dull tissue; *areole* oblong, 1 mm long, 0.5 mm wide; funicle folded and expanded into a terminal, conical, white *aril*. (Figure 1)

Characteristic features. Sprawling to ascending, glabrous *shrubs*. Branchlets bearing scars where phyllodes have fallen. Stipules mostly caducous. *Phyllodes* crowded, patent, very small (1.5–3 mm long, 1–3 mm wide), triangular to oblong-triangular with a broad, sessile, truncate base and terminated by a conspicuous, upwardly inflected, setose mucro 0.5–2 mm long; *longitudinal nerves* indistinct, 3–7 per face. *Gland* absent or inconspicuous. *Inflorescences* simple; *peduncles* 4–7 mm long; *basal peduncular bracts* absent; *heads* globular, 30–40-flowered. *Bracteoles c.* 2 mm long, the laminae linear-triangular, acuminate and slightly exserted in buds. *Flowers* 5-merous; *sepals* ± free, narrowly

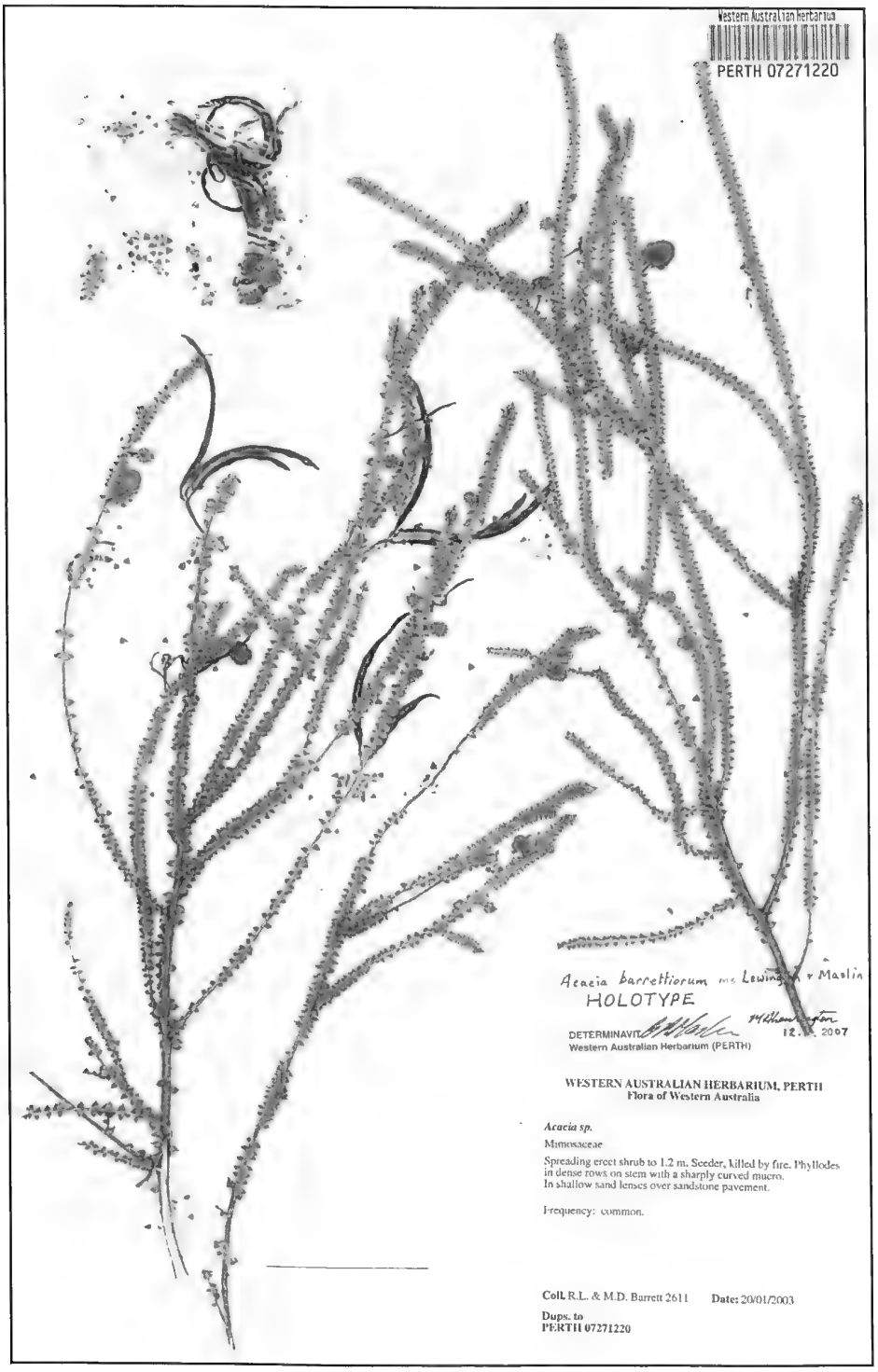

Figure 1. Holotype of *Acacia barrettiorum* Lewington & Maslin (PERTH 07271220), scale = 5 cm.

linear. *Pods* narrowly linear, 2–3 mm wide, thin-textured, resinous, dark red-brown, longitudinally finely nerved with some sparingly anastomosing. *Seeds* longitudinal in the pods, obloid; *aril* white.

Other specimens examined. WESTERN AUSTRALIA: Kimberley Region [precise locality withheld for conservation reasons] 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3892 (DNA, NSW, NT, PERTH 07692218, 07692226, 07692498, 07692528) and 25 Jan. 2007, RLB 3920 (K, MEL, PERTH 07692196, 07692501).

Distribution. Acacia barrettiorum appears to be have a very localized geographic range and is currently known from a remote, difficult to access area near the Prince Regent River in the northwest Kimberley region of Western Australia. It is known from two disjunct populations over an area of about 10 km. One population is relatively small, being restricted to the floor of a narrow valley beside a creek; the other is more extensive, covering an area about 1.5 km across. It is estimated that there exist 600+ plants in these two populations, both of which occur in the Prince Regent Nature Reserve.

Habitat. Occurs on shallow sand lenses over sandstone pavement often near small creeks in fire-protected areas. Associated species are *Borya subulata*, *Rhynchospora* sp., *Grevillea wickhamii* subsp. *pallida*, *Triodia bynoei*, *Gonocarpus implexus*, *Micraira* sp., *Sauropus* sp. A Kimberley Flora (T.E.H. Aplin *et al.* 929), *Ricinocarpos rosmarinifolius*, *Portulaca* sp., *Drosera subtilis*, *D. paradoxa* and *Utricularia georgei*.

Flowering and fruiting period. Because of the paucity of collections, it is not possible to determine the full range of flowering and fruiting. All specimens to hand were gathered in January and collectively they have buds, flowers at anthesis, immature pods, mature pods with seeds and dehisced valves present.

Conservation status. Acacia barrettiorum is listed as a Priority Two species under the Department of Environment and Conservation's (DEC) Conservation Codes for Western Australian Flora (Atkins 2008).

Etymology. The botanical name honours the brothers Russell and Matthew Barrett, botanists currently based at Kings Park and Botanic Garden, Perth. Russell and Matthew have made extensive collections of flora from remote areas of the Kimberley region since 1991 when they were living on Beverley Springs Station (now renamed Charnley River Station). Their recent collecting activity has focused on Kimberley sandstone pavement habitats, like the one where this new species was discovered in January 2003. Both Russell and Matthew have produced numerous publications on the taxonomy, ecology and conservation of Western Australian flora, with a particular focus on Kimberley plants (see http://www.bgpa.wa.gov.au/).

Common name. Barrett's Wattle

Affinities. Acacia barrettiorum is a very distinctive species on account of having very small, truncate, sessile, multi-nerved phyllodes that terminate in a long, upwardly inflexed, setose mucro (other distinguishing characteristics are noted under *Characteristic features* above). It has no apparent close relatives but may possibly be distantly related to members of the *A. deltoidea* Cunn. ex Don group (Cowan & Maslin 1990). *Acacia deltoidea* and its allies are readily distinguished from the new species in having generally larger, differently-shaped phyllodes that are not truncate at their base and which are normally terminated by a rigid, spiny tip; also, members of this group have hairy branchlets (hairs

commonly glandular), possess a pair of stipules on the abaxial side of the phyllode base, often have partially united stamens and broader pods (3 mm or more wide).

Notes. The species is killed by fire and regenerates from seed.

Acacia spectra Lewington & Maslin, *sp. nov.*

Frutices exigui penduli 4–6 m alti. *Ramuli* graciles, glabri, pruinosi. *Stipula* caduca. *Phyllodia* filiformia, in sectione transversali quadrangularia (saltem in statu sicco), 30–60 cm longa, 1.5–2 mm lata, glabra, viridia, nervis 4 longitudinalibus. *Inflorescentiae* racemorum axillarium vel terminalium vel simplices; *capitula* globularia, magna (12–13 mm diam. in statu sicca), citro-flavida. *Flores* 5-meri; *sepala* et *petala* hispidula. *Legumina* anguste oblonga, 11–15 cm longa, 8–10 mm lata, coriacea vel leviter lignosa, glabra, brunnea vel rubro-brunnea, nervo marginali non incrassato. *Semina* in leguminis obliqua, obloidea-ellipsoidea, compressa, ± sordida, pagina foveolata, brunnea; *areola* magna (5 mm longa, 2 mm lata).

Acacia sp. Mitchell River (M. King *s.n.* 15/2/2003), in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html; Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 19 February 2008].

Typus: Kimberley region, Western Australia [precise locality withheld for conservation reasons], 6 May 2005, *T. Willing s.n.* (*holo*: PERTH 07190344; *iso*: CANB, DNA, K, MEL, NSW, NY, PERTH 07190328 & 07190336).

Photographs. WorldWideWattle [online at www.worldwidewattle.com].

Wispy, pendulous *shrubs* 4–6 m tall, single-stemmed for 1–2 m before branching, crowns open, stems slender. *Bark* smooth, green and pruinose when young, perhaps aging bronze-orange, grey and breaking with a rectangular fracture on oldest plants. *Branchlets* slender, terete, glabrous, pruinose. *Stipules* caducous, triangular, not spinose, 0.4 mm long. *Phyllodes* filiform, quadrangular in section at least when dry, 30–60 cm long, 1.5–2 mm wide, wide-spreading to pendulous, straight to shallowly incurved, not rigid, sometimes slightly longitudinally wrinkled or grooved between the nerves when dry, glabrous, green; with 4 yellowish *longitudinal nerves*, one at apex of each angle; *apices* attenuate (the points normally break off with age); *pulvinus* 3–4 mm long, wrinkled, pruinose. *Gland* situated on the upper surface of the phyllode at the distal end of the pulvinus, 0.5–1 mm long, 0.4–0.6 mm wide, sometimes with a second gland near the middle of the phyllode. *Inflorescences* axillary or terminal racemes, or simple; *raceme axes* 2–8 cm long, glabrous; *peduncles* 1–3 in phyllode axils or at nodes along raceme axes, 10–18 mm long, glabrous, base ebracteate; *heads* globular, 12–13 mm diam. when dry, densely 60–70-flowered, lemon-yellow. *Bracteoles* linear-peltate, equal in length to calyx claws, glabrous, the laminae hispidulous abaxially with yellow hairs aging silvery-white. *Flowers* 5-merous; *calyx* 1.8–2 mm long, 3/4 the length of the corolla, gamosepalous, very shortly dissected into hairy lobes which are hispidulous as on bracteoles; *calyx tube* nerveless and glabrous, sometimes brown (at least when dry); *petals* 2.5 mm long, 2/3 united, apices hispidulous as on bracteoles and sepals. *Pods* pendulous, narrowly oblong, slightly raised over the seeds and not constricted between them, 11–15 cm long, 8–10 mm wide, coriaceous to slightly woody, straight to shallowly curved, openly longitudinally reticulate, glabrous, brown or reddish-brown, marginal nerve not thickened. *Seeds* oblique in the pods, seated in shallow chambers separated by narrow partitions, obloid-ellipsoid, 7–8 mm long, 3–4 mm wide, compressed (*c.* 2 mm thick), ± dull, surface minutely pitted, brown,

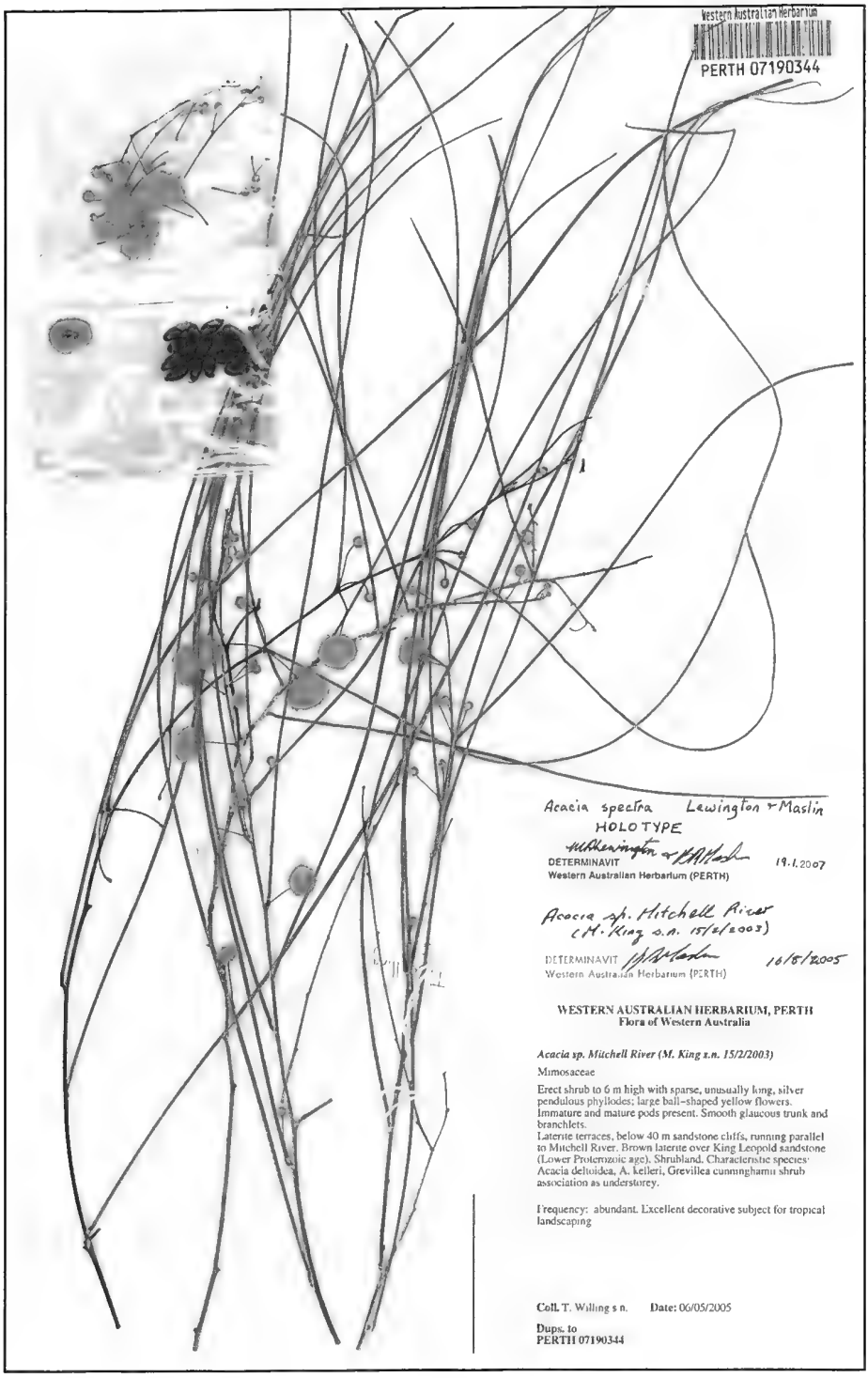

Figure 2. Holotype of *Acacia spectra* Lewington & Maslin (PERTH 07190344), scale = 5 cm.

pleurogram open towards the hilum; *areole* large (5 mm long, 2 mm wide); *funicle* abruptly expanded into a terminal conical *aril*. (Figure 2)

Characteristic features. Wispy, pendulous, *shrubs* with open crowns and slender stems. Branchlets slender, glabrous, pruinose. Stipules caducous. *Phyllodes* filiform, 30–60 cm long, 1.5–2 mm wide, wide-spreading to pendulous, not rigid, glabrous, green; with 4 yellowish *longitudinal nerves*. *Inflorescences* axillary or terminal racemes, or simple; *heads* globular, large (12–13 mm diam. when dry), densely 60–70-flowered, lemon-yellow. *Flowers* 5-merous; sepals, petals and bracteole laminae hispidulous (hairs yellow, aging silvery white). *Pods* narrowly oblong, large (11–15 cm long, 8–10 mm wide), glabrous, brown or reddish-brown, marginal nerve not thickened. *Seeds* oblique in the pods, seated in shallow chambers, minutely pitted, brown; *areole* large (5 mm long, 2 mm wide).

Other specimens examined. WESTERN AUSTRALIA: Kimberley region [precise locality withheld for conservation reasons], 10 May 2005, *C. Done* 1999 (PERTH 07190433 & 07190417). CULTIVATED: Seed from Kimberley region, grown in Darwin, *M. King s.n.*, 15 Feb. 2003 (PERTH 06231861 & 06231993) and Mar. 2003 (PERTH 07771835).

Distribution Known only from a very restricted area in the Kimberley region of northern Western Australia in the Mitchell River National Park. The area where it grows is remote and difficult to access. The new species occurs in two populations located within 1 km of one another and is quite common in the places where it grows. In some ways it is surprising that this species only came to light in 1998 because it occurs in an area which was extensively surveyed in the late 1970s (Western Australian Museum 1981). However, because of its wispy growth form *A. spectra* is easily overlooked, especially when not in flower.

Habitat. Grows on shallow sand in outwash areas formed by erosion of sandstone outcrops in association with *Acacia deltoidea*, *A. kelleri*, *Grevillea* spp., *Melaleuca* sp. and *Corymbia* sp. with *Triodia* sp. as a dense understorey.

Flowering and fruiting period. Because of the paucity of collections it is not possible to determine the full range of flowering and fruiting. All wild specimens to hand were gathered in May and bear buds, flowers at anthesis and pods with mature seeds. *Acacia spectra* has a long flowering period in cultivation (in Darwin), with mature buds seen in February and mature pods collected in March.

Conservation status. *Acacia spectra* is listed as a Priority Two species under DEC's Conservation Codes for Western Australian Flora (Atkins 2008).

Etymology. The botanical name is derived from the Latin *spectrum,* (image, apparition, spectre) in reference to the characteristic spindly, wispy growth form of this species. Similarly, the common name is in allusion to the same growth form.

Common name. Kimberley Ghost Wattle.

Affinities. Judging from its inflorescence and carpological features *A. spectra* is closely related to *A. kenneallyi* Cowan & Maslin which also has a similar growth form and ecological preference. *Acacia kenneallyi* is most readily distinguished from the new species by its flat, much broader phyllodes (6–14 mm wide) with a longer pulvinus and smaller flower heads (± 5mm diam. when dry); it occurs

in the vicinity of Prince Frederick Harbour and some islands of the Bonaparte Archipelago (Cowan & Maslin 1995: 65), about 50 km to the west of where *A. spectra* grows. These two species are referable to a group of north Australian acacias that includes *A. latescens* Benth., *A. mimula* Pedley and *A. rothii* F.M.Bailey; this group in turn is taxonomically not far removed from *A. platycarpa* F. Muell. and its allies (Cowan & Maslin 2001). In a recent molecular phylogeny study Ariati *et al.* (2006) showed that *A. platycarpa* was basal to the arid zone *A. victoriae* Benth. and *A. pyrifolia* groups (but with little bootstrap support). It is therefore of interest to note that *A. aphanoclada* Maslin, which is a member of the *A. victoriae* group of species (see Maslin 1992), is similar to *A. spectra* in having a wispy growth form, very long, narrow, 4-nerved phyllodes and globular heads which are arranged in racemes. *Acacia aphanoclada* has a very restricted distribution near Nullagine in the Pilbara region (about 1000 km south of where *A. spectra* grows) and is readily distinguished from the new species by its small, spinose stipules, smaller heads (7–9 mm diam. when dry), glabrous petals, shorter, narrower and more thinly textured pods (3–7 cm long, 6–8 mm wide, ± firmly chartaceous) and longitudinally orientated, shorter seeds (4–5 mm long) with a ± clavate aril. Although the two northern Australian species *A. jasperensis* Maconochie and *A. alleniana* Maiden have a wispy growth form, long, filiform, 4-nerved phyllodes and globular heads, they are not at all closely related to *A. spectra*, differing most obviously in having shorter and more slender phyllodes (12–24 cm long and less than 1mm wide), non-racemose inflorescences, a persistent bract at the base of their peduncles, free sepals, chartaceous pods and exarillate funicles.

Discovery and cultivation. Acacia spectra was originally found in May 1998 by Marjorie King of Top End Seeds, Darwin, Northern Territory, while walking with a group in the Kimberley region, when her attention was attracted by "large yellow ball-shaped flowers". The plant was photographed and a seed taken back to Darwin, where a plant was grown. The original cultivated plant has since died (in 2006 at 8 years old). Self-sown juveniles have now reached 5–6 m. *Acacia spectra* is an attractive plant, growing to 4 m in 4 years, with apparently a prolonged flowering period during the wet season and has definite horticultural potential. A brief account of the species, as the Kimberley Ghost Wattle, appeared in *Australian Plants* (King 2004). *Acacia spectra* has recently been included in landscape plantings around Broome in Western Australia.

Notes. Collectors observed that plants in populations sampled tended to be even-aged, suggesting the species is a pioneer fire regrowth colonizer, most likely regenerating from seed.

Acacia willingii Lewington & Maslin, *sp. nov.*

Frutices diffuso-ramosi 3–7 m alti; *rami* longi virgati vel subpenduli. *Ramuli* teretes, dense tomentosi, pilis albis. *Stipula* persistentia, 3–4 mm longa. *Phyllodia* agregata, plerumque 0.8–2.7 cm longa, 1.3–2.3 mm lata, plana, erecta, anguste oblonga, mucronata vel sub-setosa, nervis longitudinalibus obscuris. *Inflorescentiae* simplices et axillares; *pedunculi* dense albo-tomentosi; *spicae* floribus dense ordinatis. *Flores* 5-meri, *sepalis* et *petalis* albo-tomentosis. *Legumina* anguste oblonga, plana sed super semina manifeste rotundata et inter semina non constricta, ±dense pilosa. *Semina* in leguminis obliqua, obloidea, sub-nitida; *areola* tristis.

Acacia affin. *kelleri*: Maslin 1983: 369–370.

Acacia sp. Wade Creek (C.A. Gardner 1534), in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html; Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 19 February 2008].

Typus: Wade Creek area, Kimberley region, Western Australia [precise locality withheld for conservation reasons.], 18 September 2006, *T. Willing s.n.* (*holo*: PERTH 07418205, *iso*: CANB, DNA, K, MEL, NSW, NY, PERTH 07418191).

Wispy, single-stemmed *shrubs* 3–7 m tall, with an open, ±sparse canopy, the branches virgate to sub-pendulous and marked with scars where phyllodes have fallen. *Bark* light brown and fairly rough on younger branches, maturing brownish grey and longitudinally fissured. *Branchlets* terete, densely tomentose, the hairs white, patent and rather crisped. *Stipules* persistent, setaceous, 3–4 mm long, reddish brown, ciliate. *Phyllodes* crowded towards the ends of the long slender branches, narrowly oblong, (0.6–)0.8–2.7(–3) cm long, 1.3–2.3 mm wide, flat, ascending to erect, straight or sometimes very shallowly incurved, bright green, sparsely to moderately appressed-hairy; *longitudinal nerves* numerous and obscure (nerves the same colour as the inter-nerve spaces), rarely anastomosing, the central nerve slightly off-centre and normally slightly more pronounced than the rest; *apices* mucronate to sub-setose by a delicate, short mucro 0.5 mm long. *Gland* situated on upper margin of phyllode 2–4 mm above pulvinus. *Inflorescences* simple, single within axil of phyllode; *peduncles* (3–)4–7 mm long, densely white-tomentose; *spikes* 15–35 mm long, bright light golden, flowers densely arranged. *Bracteoles* linear-spathulate, 1–1.5 mm long, reddish brown, short-tomentose. *Flowers* 5-merous; *sepals c.* 0.7 mm long, united for *c.* 1/5 their length, short-tomentose abaxially; *petals c.* 1.5 mm long, united for 1/2 their length, short-tomentose abaxially, seemingly nerveless. *Pods* narrowly oblong, flat but prominently rounded over the seeds, not constricted between seeds, 3.5–8 cm long, (5–)6–7.5 mm wide, firmly chartaceous to thinly coriaceous, straight to shallowly curved, slightly resinous but not viscid, very obscurely obliquely nerved, densely puberulous to short-tomentose (the hairs 0.5–0.7 mm long, patent and slightly crisped), mid-brown, attenuate at base and apex, margins slightly thickened. *Seeds* oblique in the pod, obloid, 4–4.5 mm long, 2.8–3.3 mm wide, compressed (*c.* 2 mm thick), depressed at centre (associated with areole), sub-shiny, black to very dark brown; *areole* dull, dark brownish; *aril* cap-like, small; *funicle* folded. (Figure 3)

Characteristic features. Wispy *shrubs* with open canopy and long virgate to sub-pendulous branches. *Branchlets* densely white-tomentose, 4–7 mm long. *Stipules* persistent, 3–4 mm long. *Phyllodes* crowded, erect, narrowly oblong, mostly 0.8–2.7 cm long, 1.3–2.3 mm wide, obscurely longitudinally multi-nerved, mucronate to sub-setose by a delicate, short mucro. *Inflorescences* simple, peduncles short (mostly 4–7 mm long), densely white-tomentose, *spikes* densely flowered. *Flowers* 5-merous, sepals and petals white-tomentose. *Pods* linear, flat but obviously rounded over seeds and not constricted between them, thin-textured, ± densely puberulous to shortly tomentose. *Seeds* oblique in the pod, obloid, depressed at centre, sub-shiny; *areole* dull.

Other specimens examined. WESTERN AUSTRALIA: Wade Creek area [precise locality withheld for conservation reasons] 19 Aug. 1921, *C.A. Gardner* 1534/1034 (PERTH, see under *Notes* below re dual collecting numbers) and 6 Aug. 2006, *T. Willing s.n.* (PERTH 07788762).

Distribution. Known only from a very restricted area in the vicinity of Wade Creek in the Kimberley region of northern Western Australia. *Acacia willingii* is known with certainty from only this one area where less than 100 plants occurred (T. Willing, pers. comm.). However, the area is remote and difficult to access, therefore difficult to survey; its geographic range therefore remains uncertain at present.

Habitat. The new species occurs on horizontal sandstone terraces which adjoin a creek and are subject to monsoonal flooding. The plants usually grow in crevices in the pavement on skeletal sandy soil in Hummock Grassland of *Triodia* spp.; associated species include *Solanum vansittartense* and

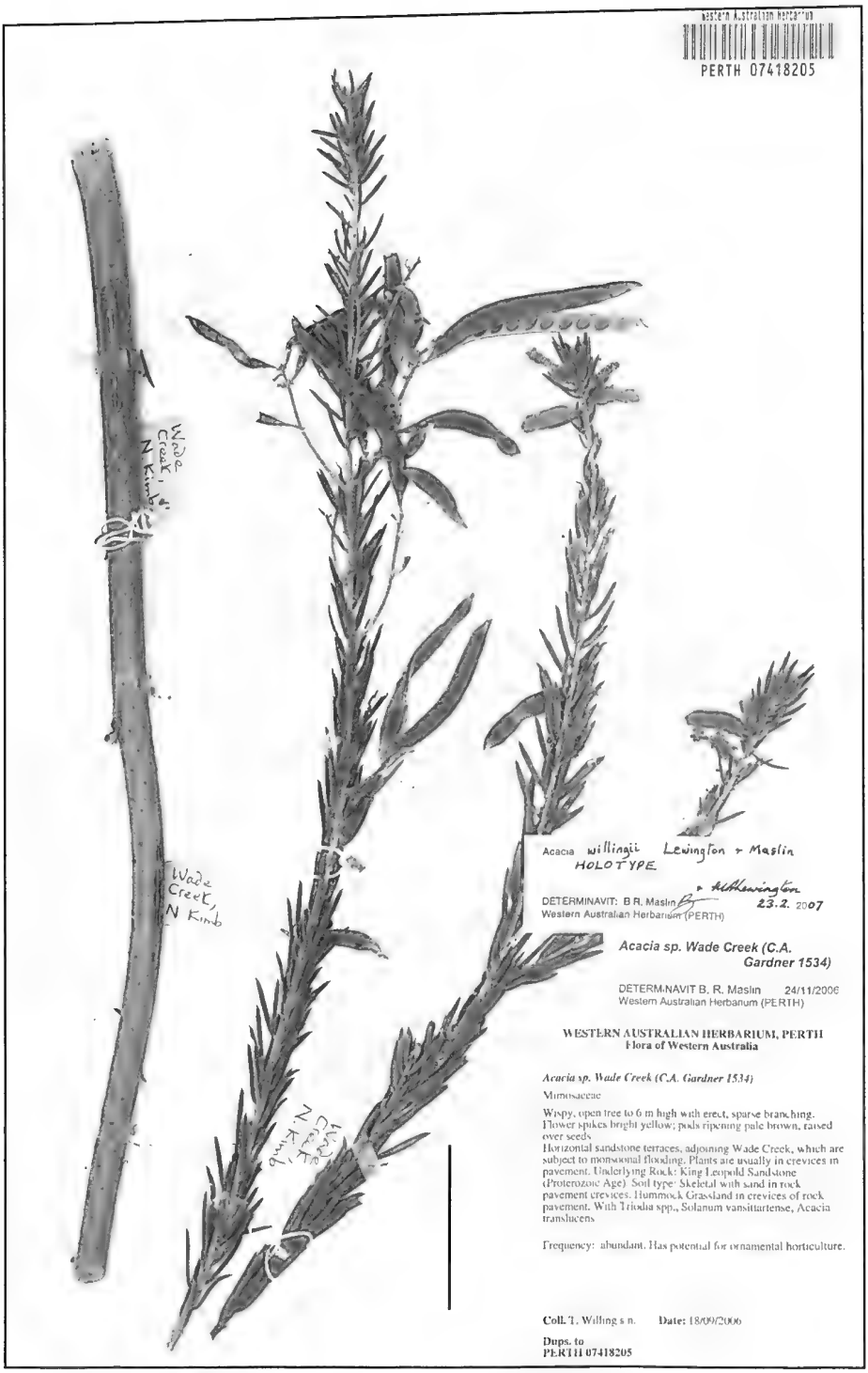

Figure 3. Holotype of *Acacia willingii*, Lewington & Maslin (PERTH 07418205), scale = 5 cm

Acacia translucens. The Wade Creek catchment is principally vegetated by savanna woodland, dominated by a Stringybark (*Eucalyptus tetrodonta*) sub-alliance, which was mapped and detailed in a 1984 survey undertaken by Forbes *et al.* (1988).

Flowering and fruiting period. Because of the paucity of collections, it is not possible to determine the full range of flowering and fruiting. Specimens collected in August and September bear buds, flowers at anthesis and pods with mature seeds.

Conservation status. *Acacia willingii* is listed as a Priority One species under DEC's Conservation Codes for Western Australian Flora (Atkins 2008).

Etymology. The botanical name honours Tim Willing, whose principal area of expertise is the Kimberley environment, particularly its flora and the environmental values of the coast and islands. Tim has lived and worked in Broome continuously for 27 years. From 1980–1995 he was a horticulturist with Parks and Gardens, Shire of Broome, and developed his abiding interest in identifying and cultivating the Kimberley flora. In 1996, he co-authored (with Kevin Kenneally and Daphne Edinger) *Broome and beyond: plants and people of the Dampier Peninsula* – a flora of the area north from Broome, for which the authors were awarded a CSIRO External Medal for Research Achievement. From 1996–2003 Tim was Conservation Officer (West Kimberley) with the Department of Conservation and Land Management (now Department of Environment and Conservation), based in Broome. During 2004 he was Acting Regional Leader (Nature Conservation) for CALM Kimberley. Since 2005 he has been Expedition Guide for Pearl Sea Coastal Cruises on board their charter vessels *Kimberley Quest 1 & 2,* operating between Broome and Wyndham. He has been the only person to recollect this new species since its original discovery in 1921 (see below).

Common name. Willing's Wattle.

Affinities. *Acacia willingii* belongs to a small group of species that includes *A. chrysochaeta* Maslin, *A. dacrydioides* Tindale and *A. kelleri* F. Muell. A key to these species, including *A. willingii* (that was then called *A.* aff. *kelleri*) is given in Maslin (1983: 370). The new species is most closely related to *A. kelleri* which is readily recognized when in fruit by its pods which are sub-moniliform, 3–5 mm wide, dark red-brown, glabrous or rarely sparsely hairy and longitudinally striate, and by its longitudinal seeds (oblique in *A. willingii* but incorrectly given as longitudinal in Maslin *l.c.*). In the absence of pods the two species are more difficult to separate as their phyllodes are similar in shape and size but there are differences in the apical mucro (distinctly setose and about 1mm long in *A. kelleri*, mucronate to sub-setose and about 0.5mm long in *A. willingii*) and phyllode nervature (the nerves are more distinct and yellowish, contrasting with the green inter-nerve tissue in *A. kelleri*, whereas in *A. willingii* the nerves are fewer and green and therefore not well demarcated from the green inter-nerve spaces). The inflorescences and flowers of the two species are very similar. *Acacia willingii* and *A. kelleri* seem not to co-occur; *A. willingii* is known from only one locality, which is at least 40 km from the nearest known occurrence of *A. kelleri*. The differences between the two species were recognised by Tim Willing (pers. comm., 23 January 2007) who commented that '[the images] show the differences between Ac Wade Creek [*A. willingii*] and *A. kelleri* pretty clearly!! At Wade Creek there is no *kelleri* at all in that catchment to my knowledge, so the taxa appear to be allopatric. The Wade Creek taxon also appears to be confined to the flood-affected horizontal rock terraces and banks of Wade Creek itself (*kelleri* is invariably above the flood level on high sandstone bluffs and terraces, above the creeks where it grows). I have not observed the Wade Creek taxon [*A. willingii*] anywhere, except at Wade Creek. In comparison to *kelleri*, the Wade Creek taxon, when mature, is much more gracile and wispy-looking. When juvenile, it is particularly ornamental and clearly has landscaping potential.

The phyllodes are also much brighter green in appearance and less obviously hairy ... [The bark of *A. kelleri*] seems to be rougher, darker and more fibrous in comparison to the smoother-barked Wade Creek taxon.' Although we concur with most of the differences noted by Willing, it is evident from examination of a wide range of herbarium material that there are no significant differences between the phyllode indumentum of the two species. *Acacia willingii* is further distinguished from *A. kelleri* in the following ways: there is a general tendency for the peduncles of *A. kelleri* to be longer [(4–)7–12 (–20) mm] than those of *A. willingii* [(3–)4–7 mm], the pods of *A. kelleri* lack the slightly thickened margins of *A. willingii*, also the seeds in *A. kelleri* are separated by a narrow band of oblique tissue in the pods (this tissue is absent in *A. willingii*) and have a dull yellow areole, in contrast to the dark brownish areole of *A. willingii*.

It is of historical interest to note that C.A. Gardner, who was the first to collect *A. willingii*, did not regard this species as distinct from *A. kelleri*. Gardner collected both species in 1921 when he was a member of the W.R. Easton Kimberley Exploration Expedition (see Forbes *et al.* 1988). *Acacia kelleri* was gathered from the Moran River on 30 June 1921 (*C.A. Gardner* 949/1449, PERTH: see under *Notes* below re dual collecting numbers) and *A. willingii* from Wade Creek on 19 August 1921 (*C.A. Gardner* 1534/1034, PERTH). Gardner determined his specimens of *A. willingii* as *A. kelleri*.

Acacia chrysochaeta shows similarities to *A. willingii* but is distinguished by its usually longer phyllodes (25–40 mm) with setose mucros, longer peduncles (6–12 mm) and particularly by the golden indumentum on its buds and wider pods (7–10 mm). *Acacia dacrydioides* is readily distinguished by its sub-terete phyllodes.

Discovery. As already noted, *A. willingii* was first collected (from Wade Creek) by C.A. Gardner in August 1921; it was not collected again until August and September 2006, by Tim Willing. This additional material, together with the comprehensive notes provided by Willing, has enabled this species to now be properly characterized.

Notes. In the Maslin key to species referred to above *A. willingii* (as *A.* aff. *kelleri*) was based on the C.A. Gardner 1921 collection and there are three herbarium sheets of this collection at the Western Australian Herbarium (PERTH). Sheets 00339385 and 00339377, which have always been part of the PERTH collection, bear the collecting number 1534, while sheet 00339393 originally formed part of C.A. Gardner's personal herbarium (it is labelled: 'Herbarium Gardnerianum made available to the Western Australian Herbarium by the Lord Abbott and Members of the Benedictine Community of New Norcia, June 1970.') and has the collecting number 1034, but is part of the same gathering. For many of the specimens which Gardner contributed to the Forests Department Herbarium (which later became the Western Australian Herbarium) between 1921 and 1924, Gardner incorporated duplicates into his own private herbarium. These were given Gardner Herbarium numbers which ran 500 below those of the corresponding specimens in the state collection. Gardner (1923) made 325 collections in the Kimberley in 1921, covering the Western Australian numbers 1321–1645 and corresponding to the Gardner numbers 821–1145 (Wilson 1988).

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Four new obligate seeder taxa of *Eucalyptus* series *Rufispermae* (Myrtaceae) from the transitional rainfall zone of south-western Australia

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Abstract

Nicolle, D. Four new obligate seeder taxa of *Eucalyptus* series *Rufispermae* (Myrtaceae) from the transitional rainfall zone of south-western Australia. *Nuytsia* 19(1): 77–97 (2009). Three new species are described, *viz. E. vittata* D.Nicolle, an obligate seeder previously confused with the respouter species *E. sheathiana* Maiden and also differing from the latter in the narrower adult leaves and smaller buds and fruits; *E. frenchiana* D.Nicolle, an obligate seeder from between Norseman and Hyden, previously confused with *E. corrugata* Luehm. but most closely related to *E. pterocarpa* C.A.Gardner ex P.J.Lang and differing from the latter in the smaller leaves, buds and fruits and the hemispherical opercula; and *E. distuberosa* D.Nicolle, an obligate seeder previously confused with the respouter species *E. pileata* Blakely. Two subspecies are recognized in *E. distuberosa*, *viz.* subsp. *distuberosa,* of widespread but scattered distribution in the southern goldfields, and subsp. *aerata* D.Nicolle, restricted to Bronzite Ridge west of Norseman. A key to the obligate seeder taxa of *E.* ser. *Rufispermae* Maiden is provided.

Introduction

Eucalyptus ser. *Rufispermae* is a large series of approximately 35 species distributed almost exclusively below the Tropic of Capricorn in low to moderate rainfall areas. Only *E. repullulans* Nicolle extends north of 23° 30' S, in the Pilbara region of Western Australia. The series is well represented in the agricultural wheatbelt areas of Western Australia and South Australia, western Victoria and south-western New South Wales. The series has possibly more taxa than any other series in the genus, perhaps exceeded only by *E.* ser. *Subulatae* Blakely (37 terminal taxa, Nicolle 2005; Nicolle *et. al* 2005; Nicolle & Whalen 2006), which is also a series of mainly mallee species with a similar, largely southern Australian distribution. A number of new taxa have been described from *E.* ser. *Rufispermae* over the last two decades as a result of ongoing field collections and understanding of the patterns of variation in the series (Lang & Brooker 1990; Brooker & Hopper 1993; Nicolle 1997; Nicolle 2000b; Hill *et al.* 2001; Brooker & Slee 2005).

Eucalyptus ser. *Rufispermae* is distinguished immediately from other series in *E.* sect. *Dumaria* L.D.Pryor & L.A.S.Johnson ex Brooker by the seeds, which have a glossy and reddish-coloured seed coat in comparison to the duller, black, pale grey to grey, yellow-grey or brown seeds of other series in the section. The classification and other distinguishing characteristics of *E.* ser. *Rufispermae* within the genus are as follows (amended from Brooker 2000): *E.* subg. *Symphyomyrtus* (Schauer)

Brooker – cotyledons folded in seeds; buds bi-operculate; seeds with ventral or terminal hilum; seed coat formed from both integuments; *E.* sect. *Dumaria* – cotyledons reniform; inflorescences axillary; stamens inflexed and all fertile; anthers versatile and opening by vertical slits; *E.* ser. *Rufispermae* – pith of branchlets with oil glands; seeds glossy and reddish.

A group of 17 species within *E.* ser. *Rufispermae*, all from southern Western Australia, are obligate seeders distinguished from the remainder of *E.* ser. *Rufispermae* by the absence of a lignotuber, the tree (or mallet) habit, and the inability to regenerate vegetatively following wildfire. The ecological relevance and taxonomic implications of closely related resprouter - obligate seeder taxon pairs have been highlighted by Nicolle (2006). A population-based genetic study of two tree subspecies (combination sprouters using the terminology of Nicolle 2006) and two mallee subspecies (lignotuber sprouters) within *E. loxophleba* using nuclear RFLP data (Hines & Byrne 2001), indicates some genetic distinction of the tree populations from the mallee populations, although this pattern was not always consistent (both the UPGMA genetic distance analysis and the continuous character maximum likelihood analysis indicating the two groups to be paraphyletic and not monophyletic) and had a low level of confidence support. Although the Hines & Byrne (2001) study indicates some genetic basis for different regenerative strategies within *E. loxophleba* (trees/combination sprouters vs mallee/lignotuber sprouters), it may be expected that the genetic distinction between obligate seeders and respouter eucalypt taxa (rather than different strategies *within* resprouter taxa) should be more pronounced. Interestingly, but not surprisingly, a similar study on the same taxa using analysis of chloroplast DNA RFLP data (Byrne & Hines 2004) indicated no distinction between the different regenerative strategies within *E. loxophleba* (and no distinction between the taxa included in the study, instead indicating a biogeographical basis of variation). The use of chloroplast DNA in eucalypts is complicated by the sharing of haplotypes among species, as demonstrated in a number of studies, including an unpublished study including resprouter and obligate seeder species within *E.* ser. *Subulatae,* which likewise indicated no distinction between regeneration strategies nor between taxa within the series (Nicolle & Byrne unpublished).

There are no published population-based genetic studies which include both obligate seeder and resprouter species, and so the question of whether populations with differing regenerative strategies comprise distinct phylogenetic lineages (i.e. taxa) or are ecotypic variants remains unclear. However, extensive cultivation trials of numerous obligate seeder eucalypt taxa do indicate that lignotuber development and regenerative strategy is genetically rather than environmentally determined in many taxa, including the four new taxa described here. A taxon-based phylogenetic study of *E.* ser. *Subulatae* and related taxa based on morphological data (Nicolle *et. al* 2006) included a number of obligate seeder species among mainly resprouter species; however, as the study was taxon-based rather than population-based, the phylogeny of resprouter - obligate seeder taxon pairs could not be ascertained. The recognition of new taxa based partly or wholly on regenerative strategy probably began with Carr and Carr (1980) and has been increasingly used as a discriminating characteristic (or set of characters) for eucalypt taxa since that time (Nicolle & Conran 1999; Nicolle 2000a; Brooker & Hopper 1991 & 2002; Nicolle & Brooker 2005).

Two of the new taxa described here (*E. vittata* and *E. distuberosa*) are relatively widespread species for which many herbarium collections have been made, but which have long remained unrecognized due to their similarity in vegetative and reproductive morphology to the mallee species *E. sheathiana* and *E. pileata* respectively. *Eucalyptus vittata* and *E. distuberosa* were identified as potential new taxa following recognition of the importance of the presence/absence of a lignotuber and its implication in plant regeneration strategy, followed by extensive field observations and cultivation of these taxa under uniform conditions at Currency Creek Arboretum in South Australia. The other two taxa described

here (*E. frenchiana* and *E. distuberosa* subsp. *aerata*) are of more restricted distribution, with their recognition largely delayed due to the past paucity of herbarium specimens, related to the relative inaccessibility of the area in which they occur. The realignment of the Hyden to Norseman road in the late 1990s led to the discovery of *E. distuberosa* subsp. *aerata* and further populations of *E. frenchiana* and the related *E. pterocarpa*. Although the absence of a lignotuber and the obligate seeder regeneration strategy is an important diagnostic characteristic in each of the four new taxa described here, each can also be distinguished from related taxa (with varying certainty) using morphological characteristics from the field and herbarium specimens alone. Of the four taxa newly described here, *E. frenchiana* is the most distinctive using morphological characteristics present in herbarium material alone, while *E. vittata* and *E. distuberosa* subsp. *aerata* can also be identified in most cases using only herbarium material. *Eucalyptus distuberosa* subsp. *distuberosa* is easily mistaken for *E. pileata* in herbaria, although there appears to be some, but possibly weak and overlapping, vegetative and reproductive morphological differences between the two species, although this is confounded by morphological variation in *E. pileata*.

Methods

All specimens of the newly described taxa and related or otherwise superficially similar taxa (including *E. assimilans* L.A.S.Johnson & K.D.Hill, *E. corrugata, E. pileata, E. pterocarpa, E. sheathiana* and *E. tenuis* Brooker & Hopper) incorporated in the collections at PERTH and AD have been examined, including type material. Digitised images of type specimens from NSW have also been examined. Descriptive data for new taxa have been taken from dried herbarium specimens where available (i.e. leaf, floral and fruit characteristics). For the new taxa *E. vittata, E. distuberosa* subsp. *distuberosa* and *E. frenchiana*, only selected specimens from a larger collection of specimens have been listed here, with specimens preferentially chosen to cover the geographical range and morphological variation within these taxa, and with duplicate specimens in multiple Australian herbaria where available. All specimens examined of *E. distuberosa* subsp. *aerata* have been listed.

Extensive field observations of wild populations of the new taxa and related taxa have been made over the last 16 years, including over 30 separate field trips (*c.* 180 field days) dedicated to collecting eucalypt taxa throughout south-western W.A., in addition to numerous other field trips examining related eucalypt taxa from elsewhere in Australia. All newly described and related taxa have been examined and collected in the field, often with an accompanying seed collection (see below). Field studies of wild populations over a number of years have permitted the observation of habit and bark characteristics, habitat preferences, and life histories of taxa following events such as wildfire. Descriptive data for the new taxa include field-recorded characteristics including habit and bark characteristics, leaf orientation, colour and sheen, inflorescence orientation and flower colour.

Multiple populations of the newly described taxa and related taxa have been grown under uniform conditions at Currency Creek Arboretum in S.A. (Nicolle 2003) for a number of years, with at least some populations of all the new taxa having reached maturity (flowered) in the arboretum. All plants growing at the arboretum have been grown from seed collected from wild population with accompanying voucher herbarium specimens. Descriptive data for the new taxa include seedling characteristics obtained from cultivated plants. Seedling morphology is not particularly discriminatory for taxa within *E.* ser. *Rufispermae*, nor of taxa within *E.* sect. *Dumaria* more generally, and this contrasts with most other taxa of *E.* subg. *Symphyomyrtus*, where seedling morphology is very often important or useful in discriminating taxa. Ongoing observations of cultivated plants have enabled the study of developmental morphology in the taxa, including leaf ontogeny related to plant maturity,

and inflorescence development. Perhaps most importantly, long-term cultivation of the new taxa have strongly indicated that the lack of a lignotuber and the obligate seeder regeneration strategy of these taxa (as well as many other obligate seeders in the genus) is genetically rather than environmentally determined.

Key to the obligate seeder taxa of *E.* ser. *Rufispermae*

1. Bark rough on trunk
  2. Branchlets pruinose
    3. Bark rough on trunk and branches; fruit ± smooth ..... **E. striaticalyx** [1]
    3: Bark rough on trunk only (blackbutt), branches smooth; fruit ± ribbed
      4. Adult leaves dull, grey-green ..... **E. clelandii**
      4: Adult leaves maturing glossy, green ..... **E. lesouefii**
  2: Branchlets not pruinose
    5. Fruit ≤5 mm in diameter ..... **E. kondininensis** [2]
    5: Fruit >5 mm in diameter
      6. Pedicels absent or to 2 mm long in bud ..... **E. fraseri** subsp. **melanobasis**
      6: Pedicels >2 mm long in bud ..... **E. striaticalyx**
1: Bark smooth throughout
  7. Inflorescences 3-flowered
    8. Opercula conical to beaked, apiculate ..... **E. pterocarpa**
    8: Opercula rounded to flattened
      9. Fruit cupular, distinctly corrugated/ribbed ..... **3. E. frenchiana**
      9: Fruit obconical, with a few ribs only ..... **E. tenuis**
  7: Inflorescences predominantly 7 or more-flowered
    10. Branchlets waxy
      11. Flowers bright yellow; opercula beaked ..... **E. woodwardii**
      11: Flowers creamy-white; opercula hemispherical
        12. Adult leaves becoming glossy with age ..... **E. georgei** subsp. **fulgida**
        12: Adult leaves dull throughout life cycle
          13. Fruits >12 mm long ..... **E. georgei** subsp. **georgei**
          13: Fruits ≤ 12 mm long
            14. Fruit >8 mm in diameter; leaves 20–40 mm wide ..... **E. assimilans**
            14: Fruit <8 mm in diameter; leaves 15–22 mm wide ..... **1. E. vittata**
    10: Branchlets not waxy
      15. Leaves dull, blue-green ..... **1. E. vittata**
      15: Leaves glossy, green
        16. Opercula rounded to hemispherical
          17. Fruit ± smooth, obconical to cupular ..... **2a. E. distuberosa** subsp. **distuberosa**
          17: Fruit distinctly ribbed, cupular ..... **2b. E. distuberosa** subsp. **aerata**
        16: Opercula conical to beaked
          18. Fruit <6 mm in diameter

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[1] The regenerative strategy of *E. striaticalyx* W.V.Fitzg. *sens. strict.* (i.e. excluding *E. gypsophila* D.Nicolle) is poorly known. While the species usually develops a tree habit, the presence of a lignotuber in the species, and its response to wildfire, is not known.

[2] The generally accepted concept of *E. kondininensis* Maiden & Blakely (Brooker & Kleinig 1990; Brooker *et. al* 2002) appears to be dimorphic in respect to regenerative strategy. The centrally-distributed core area of the species, occurring mainly on subdued topography around salt lakes, and including the type locality of Kondinin, appear to be lignotuberous trees or more rarely mallees, while populations occurring on higher ground peripheral to this (e.g. Cargannocking Hill, Karlgarin Hill, Hatter Hill) are mainly non-lignotuberous mallets (obligate seeders). These non-lignotuberous populations, while very similar to typical *E. kondininensis* in bark, vegetative and reproductive morphology, may be closer to the obligate seeder species *E. polita* Brooker & Hopper; however further research is necessary to clarify the status of these species.

19. Buds and fruit ± sessile; opercula conical..... **E. polita**
19: Buds and fruits pedicellate; opercula shortly beaked..... **E. spreta**
18: Fruit >6 mm in diameter
20. Peduncles <5 mm long; pedicels absent..... **E. valens**
20: Peduncles 2–13 mm long; pedicels 0–5 mm long..... **E. fraseri subsp. fraseri**

Two obligate seeder species described recently by Hill *et al.* (2001) are not recognised as distinct here. These are *E. paralimnetica* L.A.S.Johnson & K.D.Hill, which I cannot distinguish from *E. spreta* L.A.S.Johnson & K.D.Hill using morphology from field observations, herbarium specimens and cultivated seedlings, and *E. redimulculifera* L.A.S.Johnson & K.D.Hill which I consider to represent an intergrading population or hybrid swarm between *E. vittata* and *E. spreta* (see *Notes* under *E. vittata*).

Taxonomy

1. Eucalyptus vittata D.Nicolle, *sp. nov.*

Affinis *Eucalypto sheathianae* Maiden sed habitu arborescenti (forma 'mallet'), absentia lignotuberis, foliis adultis angustioribusque et alabastris fructibusque plerumque parvioribus differt.

Typus: breakaways *c.* 55 km east of Southern Cross – Forrestania road on Hyden – Norseman road, Western Australia, 32° 16' 54" S, 120° 15' 55" E, 16 July 2001, *D. Nicolle* 3830 *& M.E. French* (*holo*: PERTH 07219601; *iso*: CANB).

Eucalyptus sp. Southern Goldfields (D. Nicolle & M. French DN 3652); *Eucalyptus dendrosheath* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/index.html [accessed 1 January 2009].

Distinguished within the series by its combination of obligate seeder regenerative strategy; absence of a lignotuber; completely smooth bark; waxy branchlets; dull, blue-green leaves; 7-flowered inflorescences; variably waxy, ± smooth buds with a rounded operculum and variably waxy, ± smooth, cupular fruits.

Mallet 6–14 m tall; lignotuber absent (obligate seeder). *Bark* smooth throughout, grey to light yellow-grey over pale salmon-cream to white, decorticating in long ribbons which are seasonally conspicuous. *Branchlets* waxy, with pith glands. *Seedling leaves* petiolate, ovate, slightly discolorous, slightly glossy, green to slightly blue-green, the new growth slightly waxy; seedling stems slightly angular to square, moderately glandular. *Adult leaves* petiolate; lamina narrow-lanceolate to lanceolate and slightly falcate, 70–130 mm long × 8–17 mm wide, dull, blue-green; vein reticulation moderate to dense with scattered island and intersectional oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncles terete to slightly angular, 8–13 mm long; pedicels terete, 3–6 mm long. *Flower buds* pedicellate, often waxy, 9–11 mm long × 4–6 mm wide; hypanthia cupular, generally smooth; opercula conical to pileate, smooth or slightly longitudinally ribbed (ribs less than 1 mm deep). *Flowers* white. *Fruits* pedicellate, often waxy, cupular to barrel-shaped to slightly campanulate, 6–7 mm long × 5–7 mm wide; disc slightly descending to descending; valves 4, enclosed or to rim level. *Seeds* flattened-angular, glossy and reddish-brown. (Figures 1, 2)

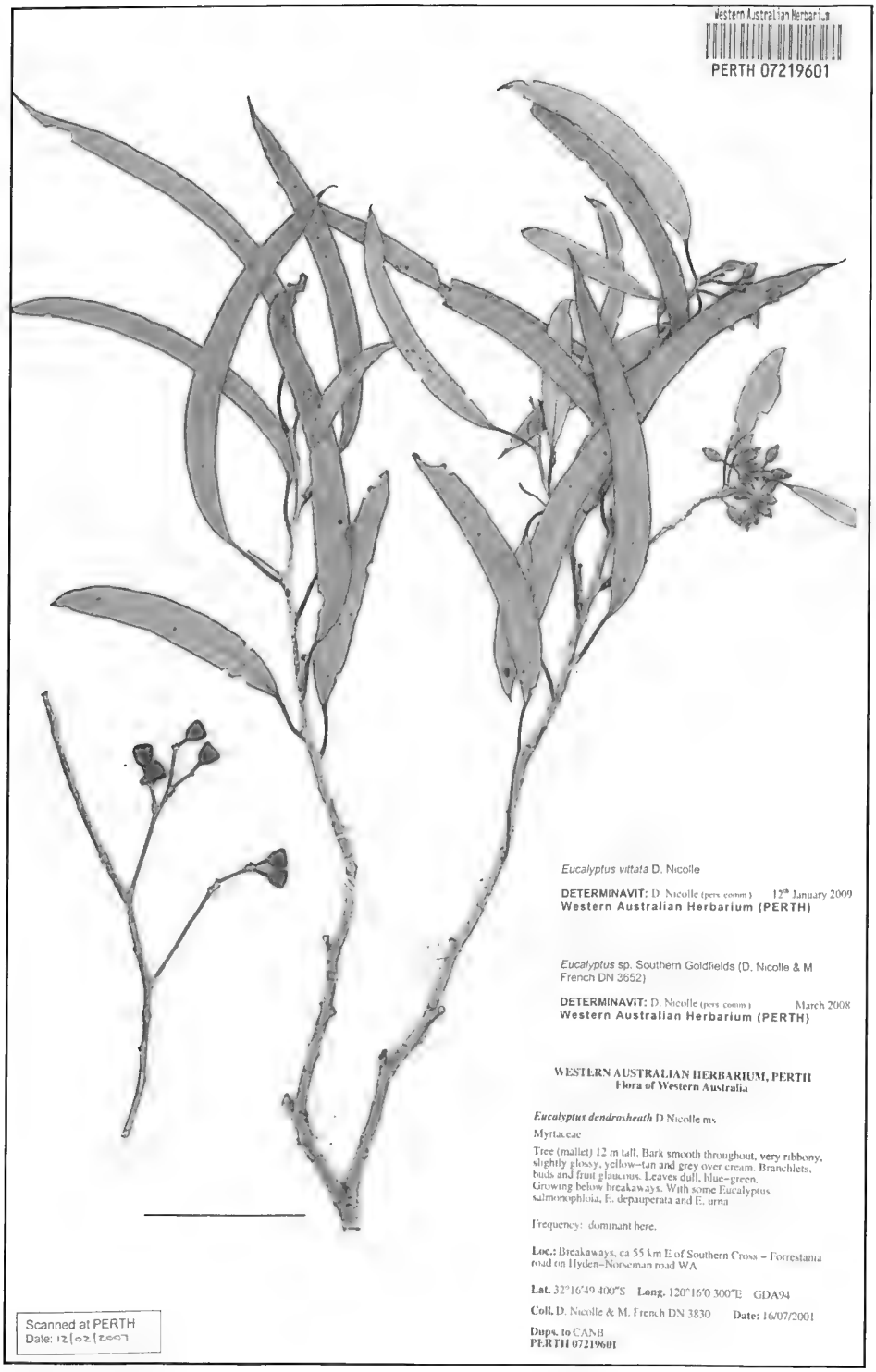

Figure 1. Holotype of *Eucalyptus vittata* (*D. Nicolle* 3830 & *M.E. French*), scale = 5 cm..

Figure 2. *Eucalyptus vittata* habit – crossroads of Holland Track and Lake Johnston–Coolgardie road, 12 Sep. 2004, *D. Nicolle* 4754 (CANB, PERTH).

Selected specimens examined: WESTERN AUSTRALIA: 22.4 miles N of Bullfinch towards Die Hardy Range, 11 Feb. 1970, *M.I.H. Brooker* 2442 (AD, PERTH); 57 km W of Coolgardie towards Southern Cross, 6 Apr. 1977, *M.I.H. Brooker* 5664 (AD, CANB, PERTH); 63 km from Norseman towards Balladonia, 2 Sep. 1998, *M.I.H. Brooker* 12928 *& A.V. Slee* (CANB, PERTH); E of Elachbutting Hill, 10 Apr. 1998, *M.E. French* 430 (PERTH); 20.8 km W of Norseman–Coolgardie road on track to Hyden, 7 Nov. 1983, *K. Hill* 604, *L. Johnson, D. Blaxell*, M.I.H. Brooker & S.D. Hopper (NSW, PERTH); 68 km E of Norseman on Highway 1, 14 Nov. 1983, *K. Hill* 695 *& D. Blaxell* (NSW, PERTH); 88.8 km E of Norseman on highway, 4 Nov. 1986, *K. Hill* 2214 *& L.A.S. Johnson* (NSW, PERTH); 13.4 km from Yellowdine towards Boorabin on Great Eastern Hwy, 1 Oct. 2000, *D. Nicolle* 3474 *& M.E. French* (CANB, PERTH); N of Lake Deborah West on vermin proof fence, 1 Oct. 2000, *D. Nicolle* 3484 *& M.E. French* (CANB, PERTH); E of Bronzite Ridge on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3652 *& M.E. French* (CANB, PERTH); 7.2 km S of Lake Cronin crossroads towards South Ironcap, 10 Nov. 2000, *D. Nicolle* 3667 *& M.E. French* (CANB, PERTH); 31.1 km S of Dundas Nature Reserve boundary gate with Southern Hills Station on the Fraser Range – Mt Ridley track, 18 July 2001, *D. Nicolle* 3876 *& M.E. French* (CANB, PERTH); cross roads of Holland Track and Lake Johnston – Coolgardie road, 12 Sep. 2004, *D. Nicolle* 4754 (CANB, PERTH).

Distribution and habitat. Eucalyptus vittata is relatively widespread and common on the north-eastern margin of the wheatbelt in Western Australia, where it is distributed from the Hamersley Lakes area in the north-west, south to the Varley area and eastwards to the Fraser Range (Figure 3). The

species occurs on pale red to pale brown sandy loams to clay loams, often on flats around dry salt lakes and clay pans or on runoff flats below low breakaways. *Eucalyptus vittata* sometimes occurs in more or less pure, even-aged mallet stands with few understorey species, or in mixed mallee-mallet woodland vegetation. Associated eucalypt species include *E. alipes*, *E. celastroides* subsp. *virella*, *E. cylindrocarpa*, *E. eremophila*, *E. exigua*, *E. horistes*, *E. kochii* subsp. *yellowdinensis*, *E. laevis*, *E. melanoxylon*, *E. moderata*, *E. myriadena*, *E. prolixa*, *E. salicola*, *E. salmonophloia*, *E. salubris*, *E. tenera*, *E. transcontinentalis*, *E. urna* and *E. yilgarnensis*.

Conservation status. Eucalyptus vittata is of scattered occurrence over a relatively wide area and is not considered to be at risk. Recorded from Dundas Conservation Reserve.

Etymology. From the Latin *vittatus* (decorated or bound with a ribbon), referring to the smooth bark which is seasonally decorticated to become conspicuous as long ribbons hanging in the crown.

Notes. Eucalyptus vittata has long been included in *E. sheathiana*, from which the former differs most notably in the non-lignotuberous, mallet habit (Figure 2). *Eucalyptus sheathiana* is consistently a lignotuberous mallee (Figure 4) and the distributions of the two species do not appear to overlap, with *E. sheathiana* having a more westerly distribution between about Mukinbudin and Newdegate (Figure 3). The adult leaves of *E. vittata* also tend to be narrower and the buds and fruits smaller than in *E. sheathiana*, enabling herbarium specimens to be distinguished.

Eucalyptus vittata is perhaps most closely related to *E. assimilans*, differing from the latter in the smaller and narrower adult leaves and the smaller buds and fruits. *Eucalyptus assimilans* occurs to the east of the Fraser Range (Figure 2). The related *E. georgei* Brooker & Blaxell, which occurs within the distribution of *E. vittata* in the Bremer Range to Lake Johnston area (but is ecologically separated, with *E. georgei* generally occurring on higher, more undulating topography), also has larger and broader adult leaves and larger buds and fruits than *E. vittata.*

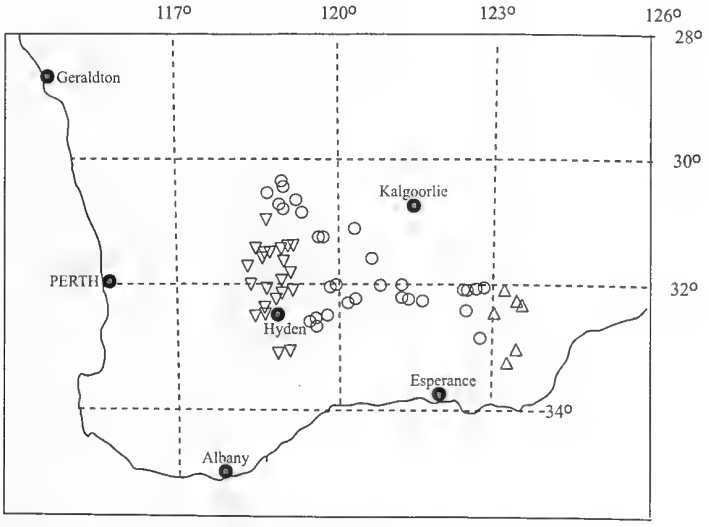

Figure 3. Distribution of *Eucalyptus sheathiana* (▽), *E. vittata* (○) and *E. assimilans* (△) in south-west Western Australia.

Figure 4. *Eucalyptus sheathiana* habit – Ivey Road, south of Bodallin, 21 Sep. 2004, *D. Nicolle* 4787 *& M.E. French* (PERTH).

Eucalyptus vittata appears to intergrade with the more distantly related *E. kondininensis* Maiden & Blakely over a small distance in the Lake Varley area (see Appendix), with intergrade individuals conspicuous in the field due to their intermediate bark characteristics (*E. kondininensis* has rough, dark bark on the trunk and primary branches). An intergrading population between *E. vittata* and *E. spreta* is known north-west of Norseman, with the type of *E. redimiculifera* representing this intergrade (see Appendix).

2. Eucalyptus distuberosa D.Nicolle, *sp. nov.*

Affinis *Eucalypto piliatae* Blakely sed habitu arborescenti (forma 'mallet'), absentia lignotuberis differt.

Typus: north-east of Yellowdine on vermin proof fence, Western Australia, 31° 09' 53" S, 119° 50' 19" E, 1 October 2000, *D. Nicolle* 3480 *& M.E. French* (*holo*: PERTH 05789206; *iso*: CANB).

Eucalyptus sp. Southern Cross (D. Nicolle & M. French DN 3480); *Eucalyptus distuberosa* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html [accessed 1 January 2009].

Distinguished within the series by its combination of obligate seeder regenerative strategy; absence of a lignotuber; completely smooth bark; lack of wax on all parts; glossy, green leaves; 7-flowered inflorescences; buds with a rounded operculum and cupular fruits.

Mallet 5–14 m tall; lignotuber absent (obligate seeder). *Bark* smooth throughout, dark grey to tan over orange-tan to creamy-white, decorticating in long ribbons which are often seasonally conspicuous.

Branchlets not waxy, with pith glands. *Seedling leaves* petiolate, ovate, slightly discolorous, more or less glossy, green to slightly blue-green, the new growth sometimes slightly waxy; seedling stems slightly angular to square, moderately glandular. *Adult leaves* petiolate; lamina lanceolate, 60–120 mm long × 8–22 mm wide, glossy, dark green; vein reticulation moderate to dense; oil glands moderately dense, island and intersectional. *Inflorescences* axillary, unbranched, predominantly 7-flowered; peduncles terete to slightly angular, 5–13 mm long; pedicels terete, 3–6 mm long. *Flower buds* not waxy, 7–10 mm long × 4.5–7 mm wide; hypanthia cupular; opercula equal to or slightly wider than hypanthia, hemispherical to pileate. *Flowers* white. *Fruits* pedicellate, not waxy, smooth to prominently ribbed, cupular to slightly campanulate or obconical, 5–8 mm long × 6–8 mm wide; disc level to descending; valves 3 or 4, around rim level. *Seeds* flattened-angular, glossy and reddish-brown.

Etymology. From the Latin *dis* (without; not) and *tuberosus* (full of lumps or protuberances), referring to the absence of a lignotuber in this species, which distinguishes it from the closely related, lignotuberous *E. pileata.*

Notes. Eucalyptus distuberosa has long been included in *E. pileata* Blakely (Figure 5), from which it consistently differs in the non-lignotuberous, mallet habit. Brooker & Kleinig (1990) illustrate *E. distuberosa* as the habit photo of *E. pileata* in their treatment of the eucalypts of south-Western Australia. *Eucalyptus pileata* is a lignotuberous mallee with a more widespread distribution than *E. distuberosa*, extending south to the Raventhorpe area and west to the Lake Grace area. The distribution of the two species significantly overlap; however they are not known to be associated, with *E. distuberosa* occurring on heavy soils in woodland-dominated vegetation and *E. pileata* occurring on yellow sands in open mallee scrub where their distributions overlap.

More recently, *E. distuberosa* has also been confused with *E. tenuis*, both of which share the non-lignotuberous mallet habit. *Eucalyptus distuberosa* is distinguished from *E. tenuis* by the predominantly seven-flowered inflorescences (consistently three-flowered in *E. tenuis*), the generally shorter pedicels (to 20 mm long in *E. tenuis*) and the more cupular fruits (obconical fruits in *E. tenuis*). The distribution of the two species largely overlaps south-west of Coolgardie in the Hyden scrub, and intergrades between the two species are known (see Appendix).

Two subspecies are recognized in *E. distuberosa*, differing primarily in flower bud and fruit ornamentation.

2a. Eucalyptus distuberosa D.Nicolle subsp. **distuberosa**

Distinguished within the series by its combination of obligate seeder regenerative strategy; absence of a lignotuber; completely smooth bark; lack of wax on all parts; glossy, green leaves; 7-flowered inflorescences; ± smooth buds with a rounded operculum and ± smooth, cupular fruits.

Distinguished from subsp. *aerata* by the smooth or faintly ribbed flower buds (including opercula) and fruits.

Adult leaves 70–120 mm long × 10–22 mm wide. *Flower buds* 7–9 mm long × 5–7 mm wide; hypanthia smooth or shallowly ribbed; opercula usually slightly wider than hypanthia, shallowly ribbed (ribs less than 1 mm deep). *Fruits* cupular to slightly campanulate, smooth to faintly striate, 6–8 mm long × 6–8 mm wide; valves usually 4. (Figures 6, 7)

Figure 5. *Eucalyptus pileata* habit – Lake Johnston–Coolgardie road, 12 Sep. 2004, *D. Nicolle* 4752 (CANB, PERTH).

Selected specimens examined. WESTERN AUSTRALIA: 88 km W of Bullabulling, 20 Aug. 1979, *M.I.H. Brooker* 6394 (PERTH); E of Banker Mount Day Track on Holland Track, 17 Apr. 2003, *M.E. French* 1528 (PERTH); N of Great Eastern Highway, E of Karalee Rocks, 20 Apr. 2003, *M.E. French* 1545 (PERTH); N of Great Eastern Highway, W of Karalee Rock, 20 Apr. 2003, *M.E. French* 1548 (PERTH); on Trans Australia railway road between Jaurdi and Wallaroo sidings, W of Coolgardie, 7 Dec. 2003, *M.E. French* 1568 (PERTH); E from Yellowdine, 3 Nov. 1965, *C.A. Gardner* 16302 (PERTH); 74.2 km of Yellowdine on highway, Coolgardie subdivision, 26 Nov. 1986, *K. Hill* 2628 *& L.A.S. Johnson* (NSW, PERTH); *c.* 83 km E of Coolgardie turnoff on the new Hyden to Norseman road, 16 July 2001, *D. Nicolle* 3846 *& M.E. French* (AD, CANB, PERTH).

Distribution and habitat. The distribution of *E. distuberosa* subsp. *distuberosa* is imperfectly known, but appears to have a scattered distribution in the scrub of Western Australia's central and southern goldfields, from Jaurdi area in the north, southwards towards Norseman. (Figure 8). The subspecies occurs on more or less level topography or on slight rises of pale orange to red-brown sandy loams to clay loams, often in small, even-aged, pure stands or in mixed mallee-mallet woodland. Associated eucalypts include *E. kochii, E. loxophleba* subsp. *lissophloia, E. moderata, E. oleosa, E. salmonophloia, E. subangusta* subsp. *subangusta, E. tenera, E. tortilis, E. urna* and *E. yilgarnensis*.

Conservation status. Eucalyptus distuberosa is of very scattered distribution but is moderately widespread and is not considered to be at risk. The species has not been recorded from a conservation reserve.

Figure 6. Holotype of *Eucalyptus distuberosa* subsp. *distuberosa* (*D. Nicolle* 3480 *& M.E. French*), scale = 5 cm.

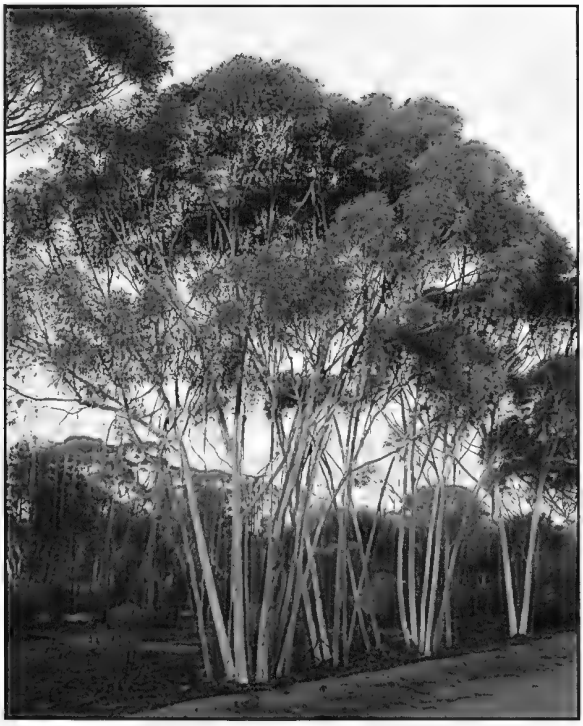

Figure 7. *Eucalyptus distuberosa* subsp. *distuberosa* habit – Great Eastern Highway between Southern Cross and Coolgardie, 11 Aug. 2003, *D. Nicolle* 4616 (AD, PERTH). Note that these plants are closely-spaced single-stemmed trees (mallets) and not multi-stemmed mallees.

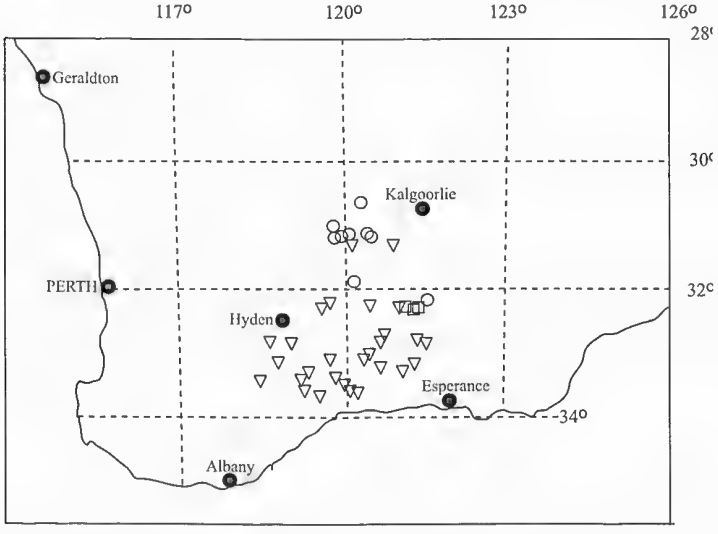

Figure 8. Distribution of *Eucalyptus pileata* (▽), *E. distuberosa* subsp. *distuberosa* (○) and *E. distuberosa* subsp. *aerata* (□) in south-west Western Australia.

Notes. Distinguished from the much more restricted *E. distuberosa* subsp. *aerata* in the smooth or faintly ribbed buds and fruit. Intergrades between the two subspecies are known (see Appendix).

2b. Eucalyptus distuberosa D.Nicolle subsp. **aerata** D.Nicolle, *subsp. nov.*

A subspecie typica alabastris fructibusque prominenter costatis differt.

Typus: Hyden to Norseman road, Western Australia, [precise locality withheld for conservation reasons], 10 November 2000, *D. Nicolle* 3653 *& M.E. French* (*holo*: PERTH 05782902; *iso*: AD, CANB)

Eucalyptus sp. Bronzite Ridge (D. Nicolle & M. French DN 3653); *Eucalyptus aerisica* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html [accessed 1 Jan. 2009].

Distinguished within the series by its combination of obligate seeder, non-lignotuberous habit; completely smooth bark; lack of pruinosity; glossy, green leaves; 7-flowered inflorescences; prominently ribbed buds with a rounded operculum and prominently ribbed, cupular fruits.

Distinguished from *E. distuberosa* subsp. *distuberosa* in the prominently ribbed buds and fruit.

Adult leaves 60–90 mm long × 8–12 mm wide. *Flower buds* 8–10 mm long × 4.5–6 mm wide; hypanthia prominently ribbed (ribs *c.* 1 mm deep); opercula equal to or slightly wider than hypanthia, prominently ribbed (ribs *c.* 1 mm deep). *Fruits* cupular to obconical, prominently ribbed (ribs *c.* 1 mm deep), 5–7 mm long × 6–7.5 mm wide; valves 3 or 4. (Figures 9, 10)

Specimens examined. WESTERN AUSTRALIA: Bronzite Ridge on new road to Norseman, Hyden–Coolgardie Road, 16 Dec. 2000, *M.E. French* 1240 (PERTH); Hyden–Norseman Road, SE of Disappointment Rock near Bronzite Ridge, 1 Mar. 2003, *M.E. French* 1502 (PERTH); Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3655 *& M.E. French* (CANB, PERTH); Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3657 *& M.E. French* (CANB, PERTH); Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3658 *& M.E. French* (PERTH); Bronzite Ridge, at highest point on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3659 *& M.E. French* (PERTH); 51.6 km E of Coolgardie turnoff on the Hyden to Norseman road, 16 July 2001, *D. Nicolle* 3844 *& M.E. French* (CANB, PERTH).

Distribution and habitat. Restricted to Bronzite Ridge between Lake Johnston and Norseman (Figure 8). It often occurs in near pure, even-aged mallet stands with other obligate seeder eucalypt species, or in mixed mallee-mallet vegetation. Associated eucalypts include *E. celastroides* subsp. *celastroides, E. diptera* or *E. diptera – E. tortilis* intergrades, *E. eremophila, E. frenchiana, E. livida, E. oleosa* or *E. oleosa – E. longicornis* intergrades, *E. prolixa, E. pterocarpa, E. salmonophloia* and *E. urna.*

Conservation status. Recently listed as Priority One under the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (Atkins 2008). Known along a single section of the new alignment of the Hyden to Norseman road, where it is relatively common. The taxon is in need of further survey to ascertain the extent of its distribution and its conservation status.

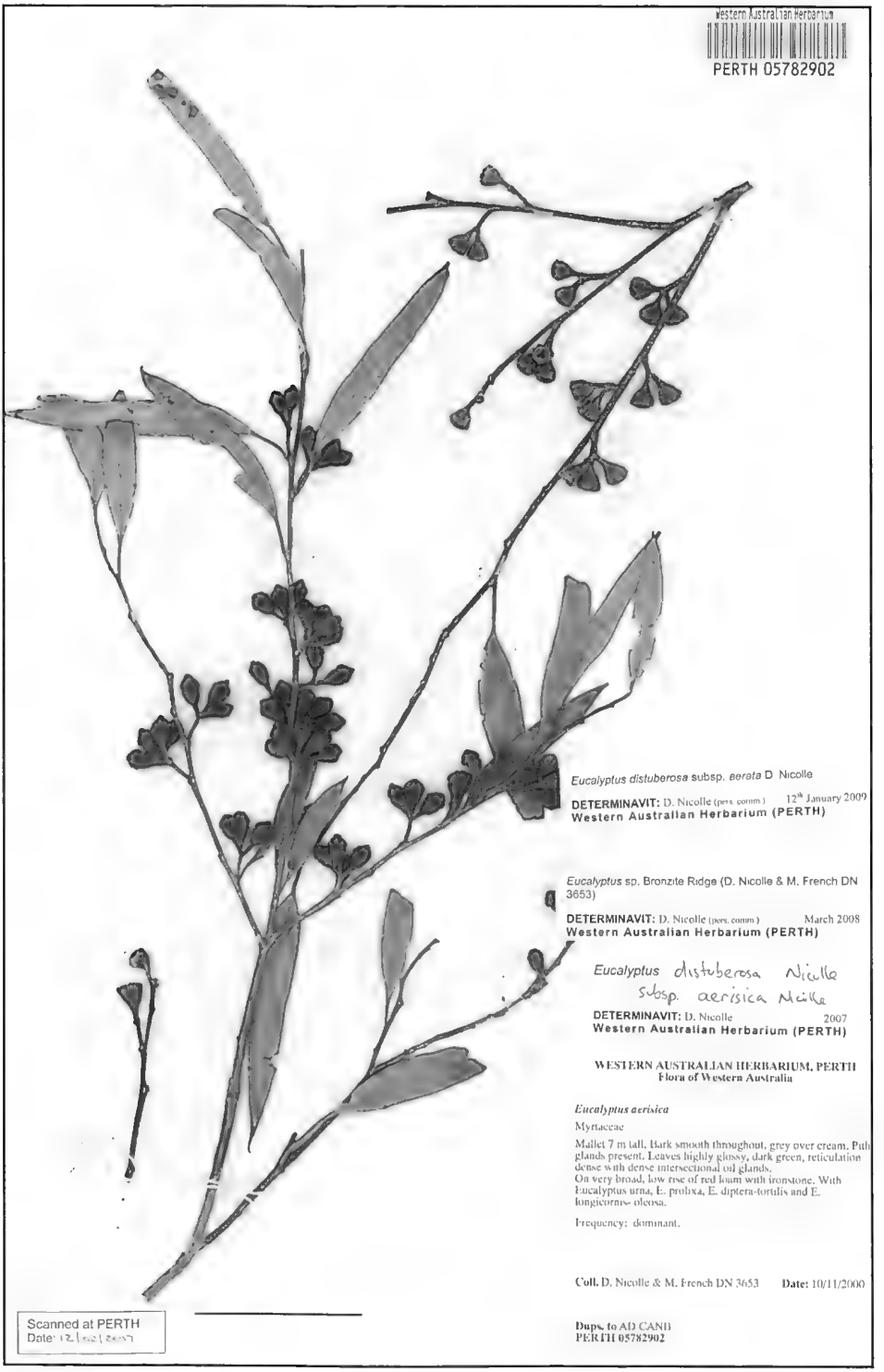

Figure 9. Holotype of *Eucalyptus distuberosa* subsp. *aerata* (*D. Nicolle* 3653 *& M.E. French*), scale = 5 cm.

Figure 10. *Eucalyptus distuberosa* subsp. *aerata* habit – Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3653 & *M.E. French* (AD, CANB, PERTH).

Etymology. From the Latin *aerata* (furnished or covered with bronze), alluding to the species' discovery and apparent restriction to Bronzite Ridge, west of Norseman.

Notes. Distinguished from the more widespread *E. distuberosa* subsp. *distuberosa* in the prominently ribbed buds and fruit. Intergrades between the two subspecies are known (see Appendix).

This taxon appears to have been first collected in 2000, following the realignment of the Hyden to Norseman road over Bronzite Ridge. Initial collection of populations from Bronzite Ridge in 2000 indicated that it was probably an undescribed taxon. Subsequent collections and study of these populations indicated that although locally uniform and distinctive in bud and fruit ornamentation, the populations represented a geographical variant of another undescribed taxon (*E. distuberosa* subsp. *distuberosa*), with intergrading specimens known (see Appendix).

3. Eucalyptus frenchiana D.Nicolle, *sp. nov.*

Affinis *Eucalypto pterocarpae* Gardner ex Lang sed foliis adultis parvioribus, alibastris parvioribus, operculo hemispherico brevioreque et fructibusque parvioribus differt.

Typus: 6.8 km west of the Coolgardie turnoff towards Hyden on the new Hyden to Norseman road, Western Australia, 32° 03' 19" S, 120° 42' 36" E, 10 November 2000, *D. Nicolle* 3663 & *M.E. French* (*holo*: PERTH 05783429; *iso*: CANB).

Eucalyptus sp. Lake Johnston (D. Nicolle & M. French DN 3663); *Eucalyptus evexa* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html [accessed 1 January 2009].

Eucalyptus obtusata D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html [accessed 1 January 2009].

Eucalyptus pterocarpa subsp. *obtusata* Brooker ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/ index.html [accessed 1 January 2009].

Distinguished within the series by its combination of obligate seeder, non-lignotuberous habit; completely smooth bark; lack of wax on all parts; glossy, green leaves; 3-flowered inflorescences; large, prominently ribbed buds with a rounded operculum and the large, prominently ribbed, cupular fruits.

Distinguished from *E. pterocarpa* in the smaller adult leaves, the smaller buds with a shorter, hemispherical operculum and the smaller fruits.

Mallet 6–14 m tall; lignotuber absent (obligate seeder). *Bark* smooth throughout, grey over light grey, tan or cream, decorticating in ribbons. *Branchlets* not waxy, with pith glands. *Seedling leaves* petiolate, ovate, discolorous, slightly glossy, light green to green; seedling stems slightly square, sparsely to moderately glandular. *Adult leaves* petiolate; lamina narrow-lanceolate, 55–100 mm long × 9–13 mm wide, highly glossy, green; vein reticulation moderate to dense; oil glands moderately dense, island and intersectional. *Inflorescences* axillary, unbranched, 3-flowered; peduncles angular to very slightly flattened, 8–13 mm long; pedicels angular, 5–11 mm long. *Flower buds* not waxy, 12–150 mm long × 8–12 mm wide; hypanthia cupular, prominently longitudinally ribbed; opercula hemispherical, prominently ribbed (ribs to 2.5 mm deep). *Flowers* white. *Fruits* not waxy, cupular to obconical, deeply ribbed (ribs 1–2 mm deep), 10–12 mm long × 10–13 mm wide; disc level; valves 4, around rim level. Seeds flattened-angular, glossy and reddish-brown. (Figure 11)

Selected specimens examined. WESTERN AUSTRALIA: 2–4 km on track to Scamp Rock, ESE of McDermid Rock, Hyden–Norseman Track, 16 Sep. 2002, *R. Butler* 174-51 (AD, CANB, NSW, PERTH); Disappointment Rock on Hyden–Norseman Track, 16 Sep. 2002, *R. Butler* 174-56 (PERTH); 60.5 km W of Coolgardie - Esperance Road on old Hyden - Norseman track, 12 May 2003, *J.A. Cochrane* 4622 *& A. Crawford* (PERTH); N on track 22 km E of Victoria Rock turnoff towards Norseman on Hyden track, 30 March 1997, *M.E. French* 165 (PERTH); 2–4 km on track to Scamp Rock, ESE McDermid Rock on Hyden-Norseman Track, 22 Apr. 1998, *M.E. French* 456 (PERTH); W of Mount Dermid Rock on Old Hyden–Norseman Track, 22 April 1998, *M.E. French* 465 (PERTH); 196.3 km E of Hyden near Hyden-Norseman track (probably Lake Johnston), 24 Sep. 1991, *P. Grayling* 791 (PERTH); 60.5 km W of Coolgardie–Norseman road on Hyden track, 25 Aug. 1988, *K. Hill* 2857 (PERTH); Lake Johnston, 13 May 1989, *S.D. Hopper* 7254 (PERTH); Hyden–Norseman Road, 23 km W McDermid Rock, E Bremer Range, 8 May 1978, *G.J. Keighery* 1702 (PERTH); 332 mile peg on Hyden - Norseman track [*c.* 195 km E of Hyden on Hyden–Norseman track, 16 Aug. 1966, *A. Kessell* 432 (PERTH); 1.5 miles E of Spinifex Rock on Hyden–Norseman track, 8 Feb. 1967, *A. Kessell* 548 (PERTH); between Hyden to Norseman road and Lake Johnston, 21 Apr. 1998, *D. Nicolle* 2286 *& M.E. French* (PERTH); between Disappointment Rock and Bronzite Ridge on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3660 *& M.E. French* (CANB, PERTH); 'Old' Hyden-Norseman road, 27 km N of junction with 'new' road, 29 Aug. 1998, *W. O'Sullivan* 431 *& P.J. White* (PERTH).

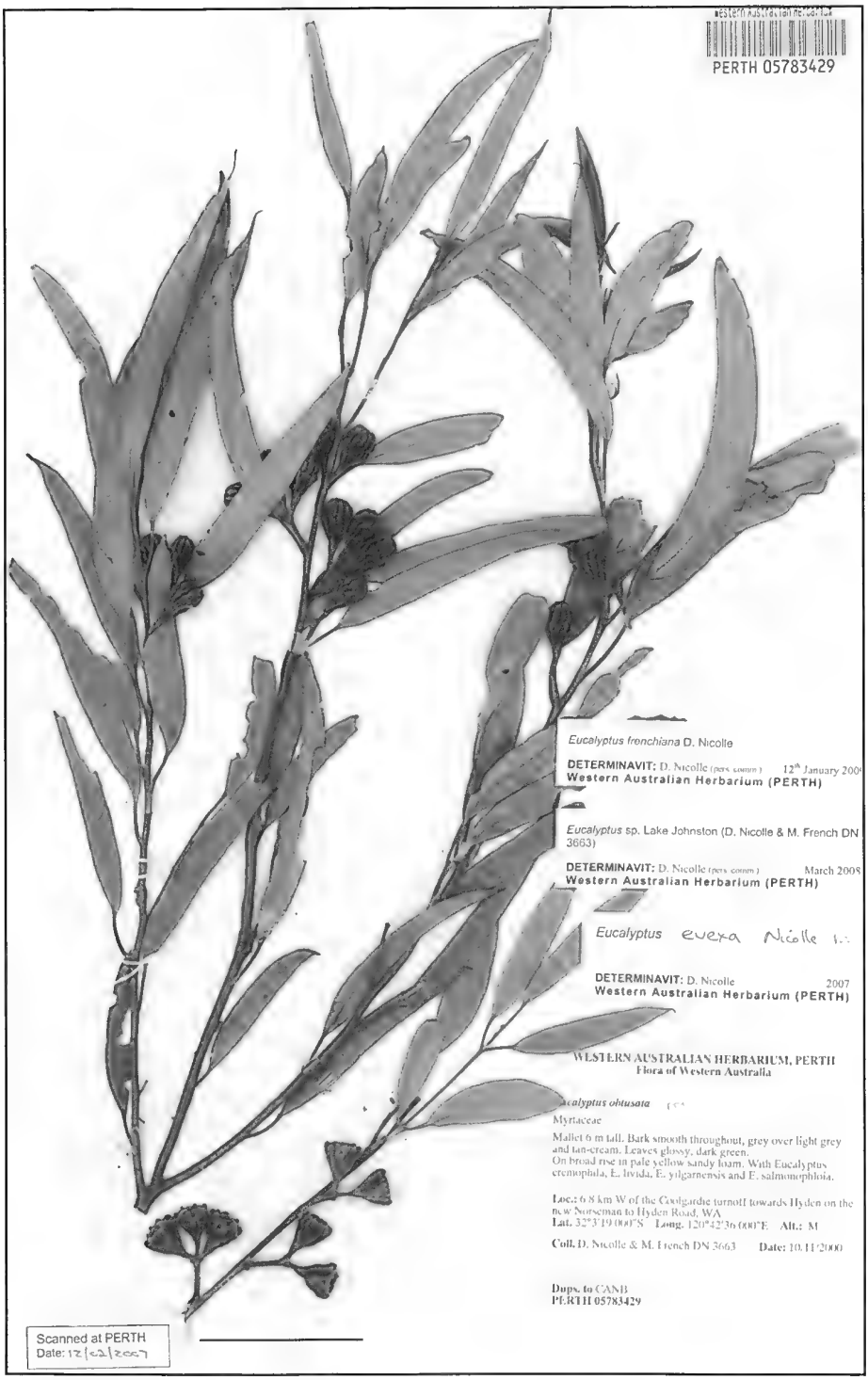

Figure 11. Holotype of *Eucalyptus frenchiana* (*D. Nicolle* 3663 & *M.E. French*), scale = 5 cm.

Distribution and habitat. Distributed in uncleared country between Hyden and Norseman, namely in the Lake Johnston area and eastwards towards Bronzite Ridge (Figure 12). It occurs as a component of mixed mallee-mallet woodland on pale yellow to brown sandy-loam to clay soils, sometimes on broad rises. Associated eucalypts include *E. distuberosa*, *E. eremophila, E. livida, E. longicornis, E. loxophleba* subsp. *lissophloia, E. salmonophloia, E. urna* and *E. yilgarnensis*.

Conservation status. Occurs in largely uncleared country and not considered to be under any immediate threat. There are relatively few collections of this species and it is not known whether the paucity of collections is due to a limited and sparse distribution or to the general lack of botanical collections away from the Hyden to Norseman road in the general area.

Etymology. Named for Malcolm E. French (1947 -), an astute and enthusiastic observer and collector of eucalypts, in recognition of his significant contributions to the understanding of the eucalypts and particularly to the discovery and recognition of many new eucalypt taxa in southern Western Australia, including this new species.

Notes. Eucalyptus frenchiana has been confused with *E. corrugata* Luehm., of *E.* ser. *Corrugatae*, with which the leaves, buds and fruits are superficially similar. *Eucalyptus frenchiana* differs from *E. corrugata* in the glossy, reddish-brown and shallowly pitted seed (dull, greyish and deeply pitted in *E. corrugata*) and the complete lack of wax (branchlets usually conspicuously waxy in *E. corrugata*).

Eucalyptus frenchiana is probably most closely related to *E. pterocarpa* Gardner ex Lang, differing most conspicuously in the shorter, hemispherical operculum (longer than the hypanthium and beaked in *E. pterocarpa*) and also in the generally smaller adult leaves, buds and fruits. The two species are not known to occur in association, with *E. pterocarpa* occurring east of Bronzite Ridge to the north-west to south-west of Norseman (Figure 12).

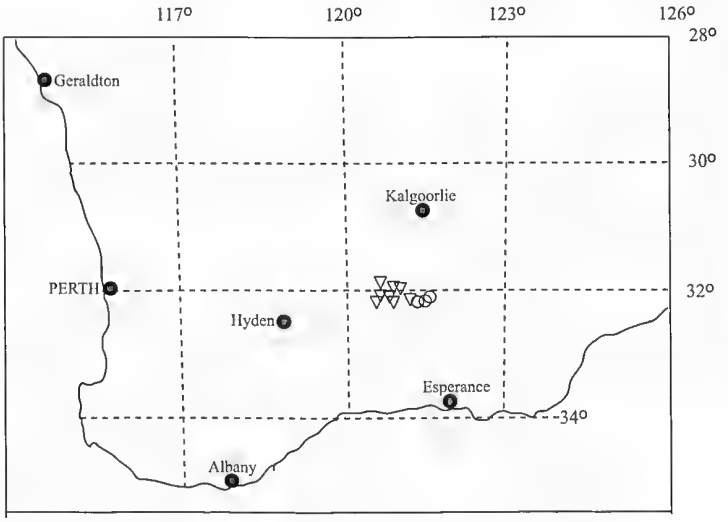

Figure 12. Distribution of *Eucalyptus frenchiana* (▽) and *E. pterocarpa* (○) in south-west Western Australia.

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I am grateful to staff at the Western Australian Herbarium and the Biodiversity Conservation Initiative team in Perth for their assistance in preparing this paper. Ryonen Butcher (BCI) has been particularly helpful in providing images of type specimens. I am once again indebted to Ian Brooker who has checked the Latin diagnoses, for accompaniment on field trips, and with whom I have shared many discussions relating to eucalypt taxomony. Detlef Schultz is thanked for the opportunity to accompany him and colleagues on several field trips transecting the south-west of Australia. This paper would not have been possible without Malcolm French, with whom I have shared many field trips and spent much time discussing taxa related to this paper. Malcolm's contribution to this paper and to the understanding of the south-west's eucalypts more generally is acknowledged in one of the new species described in this paper.

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Appendix

Intergrades and hybrids

Eucalyptus distuberosa subsp. **aerata** – subsp. **distuberosa** intergrades

Selected specimens examined. WESTERN AUSTRALIA: 69.3 km east of Coolgardie turnoff on Hyden–Norseman road, 16 July 2001, *D. Nicolle* 3845 *& M.E. French* (CANB, PERTH).

Eucalyptus vittata – E. kondininensis intergrades

Selected specimens examined. WESTERN AUSTRALIA: *c.* 2 km W of Varley, 11 Nov. 2000, *D. Nicolle* 3677 *& M.E. French* (CANB, PERTH); 1.5 km NE of Holt Rock, 15 July 2001, *D. Nicolle* 3817 *& M.E. French* (CANB, PERTH).

Eucalyptus vittata – E. spreta intergrades

Eucalyptus redimiculifera L.A.S.Johnson & K.D.Hill, *Telopea* 9(2): 316 (2001).

Typus: 5.6 km W of Highway on track turning off 11 km N of Norseman, W.A., *K.D. Hill 589, L.A.S. Johnson, D.F. Blaxell, M.I.H. Brooker & S.D. Hopper*, 6 Nov. 1983 (*holo*: NSW; *iso*: CANB, PERTH).

Selected specimens examined. WESTERN AUSTRALIA: 5 km W from the main Norseman to Coolgardie road on the track to *Eucalyptus pterocarpa*, 6 Oct. 1993, *D. Nicolle* 551 (AD, CANB, PERTH).

Eucalyptus distuberosa subsp. **distuberosa – E. tenuis** intergrades

Selected specimens examined. WESTERN AUSTRALIA: Holland Track, between Mt Holland and Lake Johnston – Coolgardie road, 18 Aug. 2003, *D. Nicolle* 4676 (PERTH).

Eucalyptus calycogona subsp. *miracula* (Myrtaceae), a new subspecies from the central wheatbelt of Western Australia

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Abstract

Nicolle, D. & French, M.E. *Eucalyptus calycogona* subsp. *miracula* (Myrtaceae), a new subspecies from the central wheatbelt of Western Australia. *Nuytsia* 19(1): 99–105 (2009). A new subspecies of *Eucalyptus calycogona* Turcz. is described, differing from the other three subspecies of *E. calycogona* by the waxy branchlets, buds and fruits, the generally broader, dull adult leaves which are bluish at least when new, the consistently elliptical to ovate seedling leaves, and the generally larger flower buds and fruits. The new subspecies is distributed on the eastern edge of the central wheatbelt in Western Australia, to the north-west of the distribution of subsp. *calycogona*. A key to *E.* ser. *Heterostemones* Benth., a map indicating the distribution of *E. calycogona* in Western Australia, and illustration of the holotype and habit of *E. calycogona* subsp. *miracula* D.Nicolle & M.E.French are included.

Introduction

Eucalyptus calycogona Turcz. is a mallee species with a scattered distribution through the wheatbelt areas of southern Australia. The species is distinguished by a large suite of characters, but is most readily identified in the field by the cylindrical to urceolate fruits which are much longer than wide, and which are square in transverse section and usually four-ribbed, and by the flowers with prominent staminodes, where the outer filaments lack anthers, are twisted, and are much longer than the inner fertile filaments. *Eucalyptus calycogona* was revised by Nicolle (2000a), who recognised three subspecies (subsp. *calycogona, spaffordii* D.Nicolle and *trachybasis* D.Nicolle), of which only subsp. *calycogona* was recognised in Western Australia.

Eucalyptus calycogona subsp. *miracula* D.Nicolle & M.E.French was first collected by us in the field in September 2000 near Waterbidden Rock, in the south of the subspecies' distribution, when we recognised the population as an atypical waxy variant of *E. calycogona* subsp. *calycogona*. Further collections from similarly waxy populations were subsequently made by us further to the north and north east. Examination of herbarium specimens at PERTH has also revealed a few earlier collections (one in 1969 and none others earlier than 1982) which were included under *E. calycogona* or *E. celastroides* Turcz. at the time, but have adult morphology matching the new subspecies described here. Ongoing field research and field collecting, examination of herbarium material in AD and PERTH, and seedling studies, both of *E. calycogona* and related taxa, indicate that populations in the central wheatbelt between Burracoppin, the Parker Range, and Woolocutty are worthy of taxonomic recognition, and

are distinctive in both adult and seedling morphology and form part of a geographical replacement pattern with the other subspecies of *E. calycogona*.

Eucalyptus calycogona belongs to *E.* ser. *Heterostemones*, which is distinguished within the genus by the combination of the following characteristics (amended from Brooker 2000):

E. subgen. *Symphyomyrtus* (Schauer) Brooker – cotyledons folded in seeds; buds bi-operculate; seeds with ventral or terminal hilum; seed coat formed from both integuments (in the very few taxa investigated, see Gauba & Pryor 1961).

E. sect. *Bisectae* Maiden ex Brooker – Cotyledons bisected; inflorescences axillary.

E. subsect. *Destitutae* Brooker – Pith of branchlets without glands.

E. ser. *Heterostemones* Benth. – Staminodes present; stamens inflexed; secondary veins of leaf visible, at a very acute angle at base of leaf; ovules in four vertical rows.

Seven species (*E. celastroides* with two subspecies and *E. calycogona* with four subspecies) are here recognised in *E.* ser. *Heterostemones*. The series is most diverse in the wheatbelt and goldfields regions of south-western Western Australia, where five species are endemic, and with two species (*E. calycogona* and *E. gracilis* F. Muell.) widespread across southern Australia, occurring in Western Australia, South Australia, Victoria and New South Wales.

Eucalyptus calycogona was revised by Nicolle (2000a), who recognised three subspecies (*calycogona, spaffordii* and *trachybasis*) and described the new obligate seeder species *E. prolixa* D.Nicolle. *Eucalyptus calycogona* and *E. prolixa* are distinguished within *E.* ser. *Heterostemones* by the cylindrical to urceolate fruits which are much longer than wide, and which are square in transverse section and usually four-ribbed. These two species differ in their habit and regenerative strategy, while herbarium specimens of *E. prolixa* may be distinguished from *E. calycogona* in their relatively long but slender fruits which are prominently four-ribbed.

Four subspecies in *E. calycogona* are now recognised with the description of subsp. *miracula* here. *Eucalyptus calycogona* subsp. *spaffordii* is endemic to Eyre Peninsula in South Australia while subsp. *trachybasis* occurs in eastern South Australia and adjacent areas of north-western Victoria and south-western New South Wales. *Eucalyptus calycogona* subsp. *calycogona* has two broad areas of distribution – the central and southern wheatbelt area of Western Australia and the peninsular region of South Australia – with a large disjunction in the more arid Nullarbor region in between.

Key to the taxa of *Eucalyptus.* ser. *Heterostemones*

1. Buds and fruits square in transverse section, at least on lower part of hypanthia
  2. Non-lignotuberous tree; obligate seeder ..... **E. prolixa**
  2: Lignotuberous mallee; resprouter
    3. Fruits obconical to cupular in outline ..... **E. quadrans**
    3: Fruits oblong to urceolate in outline (*E. calycogona*)

4. Branchlets, buds and fruits waxy; adult leaves usually dull ..... **E. calycogona** subsp. **miracula**
4: Branchlets, buds and fruits never waxy; adult leaves glossy
5. Adult leaves mostly 14–24 mm wide; fruit 6–9 mm wide, ribs prominent ..... **E. calycogona** subsp. **spaffordii**
5: Adult leaves mostly 6–15 mm wide; fruit 3–7 mm wide, ribs less prominent
6. Bark smooth or rough only at base ..... **E. calycogona** subsp. **calycogona**
6: Bark rough and tessellated on lower stems ..... **E. calycogona** subsp. **trachybasis**
1: Buds and fruits round in transverse section
7. Pedicels equal to or longer than bud length ..... **E. yilgarnensis**
7: Pedicels shorter than bud length
8. Fruits urceolate to narrowly barrel-shaped, longer than broad (*E. celastroides*)
9. Branchlets usually waxy; adult leaves bluish green ..... **E. celastroides** subsp. **celastroides**
9: Branchlets never waxy; adult leaves glossy green ..... **E. celastroides** subsp. **virella**
8: Fruits obconical to cupular to barrel-shaped, approximately equidimensional
10. Peduncles >5 mm long; upper bark smooth ..... **E. gracilis**
10: Peduncles to 5 mm long; rough bark to smaller branches ..... **E. brevipes**

Taxonomy

Eucalyptus calycogona Turcz. subsp. **miracula** D.Nicolle & M.E.French, *subsp. nov.*

A subspecie typica ramulis alabastris fructibusque pruinosis, foliis adultis hebetibus et saepe latioribus, foliis plantularum ellipticis vel ovatis, et alabastris fructibusque plerumque majoribus differt.

Typus: south-east of Marvel Loch, Western Australia, 31° 32' 43" S, 119° 35' 04" E, 21 September 2004, *D. Nicolle* 4794 *& M.E. French* (*holo*: PERTH 07155190; *iso*: AD, CANB, NSW).

Eucalyptus sp. Marvel Loch (D. Nicolle & M. French DN 4794); *Eucalyptus calycogona* subsp. *glaucissima* D. Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, http://www.chah.gov.au/apc/index.html [accessed 23 April 2008].

Distinguished within *E. calycogona* by the waxy branchlets, buds and fruits, the generally broader, dull adult leaves which are bluish at least when new, the consistently elliptical to ovate seedling leaves, and the generally larger flower buds and fruits.

Mallee 3–5 m tall; lignotuber present (lignotuber sprouter). *Bark* smooth throughout, cream to leaden-grey over pale grey to reddish-tan, decorticating in strips. *Branchlets* waxy, lacking pith glands. *Juvenile leaves* opposite for a few pairs then becoming disjunct, sessile becoming shortly petiolate, elliptical to ovate, to 40 mm long by 18 mm wide, slightly discolorous, dull, blue-green, sometimes slightly waxy; new juvenile growth and stems waxy. *Adult leaves* with petiole 11–18 mm long; lamina lanceolate to broad-lanceolate, 55–90(–110) mm long by 8–18(–22) mm wide, dull, bluish and waxy at first, maturing to dull to slightly glossy and blue-green to dark green; vein reticulation moderate with scattered island oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncles terete to angular, 7–12 mm long; pedicels angular, 2–5 mm long. *Flower buds* pedicellate, waxy, quadrangular,

9–11 mm long by 4–5 mm wide; hypanthia obconical, with four longitudinal ribs; opercula pyramidal, usually smooth, 4–5 mm long. *Stamens* white; outer filaments much longer than inner filaments and lacking anthers (staminodes). *Fruits* pedicellate, waxy when young, oblong-cylindrical to slightly urceolate and square in cross-section, with four longitudinal ribs, 9–13 mm long by 5–8 mm wide; disc vertically descending, rim thin; valves four, deeply enclosed. *Seeds* angular-ovoid, very finely pitted-reticulate, slightly glossy, brown. (Figures 1, 2)

Selected specimens. WESTERN AUSTRALIA: 26 km due SW of Bodallin, 17 Sep. 1982, *R.J. Cranfield* 2477 (PERTH); SE of South Burracoppin, 13 Aug. 2001, *M.E. French* 1387 (AD, PERTH); N of Great Eastern Highway, W of Karalee Rock, 20 Apr. 2003, *M.E. French* 1546 (PERTH); south-east of Marvel Loch on Forrestania – Southern Cross road, 16 Nov. 2003, *M.E. French* 1561 (PERTH); about 6 km SSW of Mt Caudan, Parker Range, 17 Oct. 1994, *N. Gibson & M. Lyons* 1984 (BRI, PERTH); *c.* 4.8 km SSE of Hill 444, near Olga Mine, Parker Range, 13 Oct. 1994, *N. Gibson & M. Lyons* 2246 (NSW, PERTH); *c.* 3 km SE of Waterbidden Rock, 17 Sep. 2000, *D. Nicolle* 3450 & *M.E. French* (AD, CANB, PERTH); Dulyabin Rd, south-west of Bodallin, 21 Sep. 2004, *D. Nicolle* 4786 & *M.E. French* (AD, CANB, NSW, PERTH); Ivey Road, south of Bodallin, 21 Sep. 2004, *D. Nicolle* 4789 & *M.E. French* (CANB, PERTH); Meranda North Road, E of Muntadgin, 6 Jan. 2007, *D. Nicolle* 5035 & *M.E. French* (CANB, PERTH); 16 miles S Karalee, 24 Mar. 1969, *R.D. Royce* 8563 (PERTH); 4.1 km S on Parker Range Road from Southern Cross turnoff, 31 Oct. 2000, *A.V. Slee* 4318 & *J. Connors* (CANB, PERTH); 24 km SSE of Carrabin (NNE of Noombenderry Rock), 15–17 Sep. 1982, *A. Strid* 20322 (PERTH); Cramphorne Road, 2.1 km W of Nulla Nulla Road, 28 Feb. 1993, *P. White* 549 (PERTH).

Distribution and habitat. Eucalyptus calycogona subsp. *miracula* is distributed on the eastern edge of the central wheatbelt in south-west Western Australia within the transitional rainfall zone of Hopper (1979), in the area bounded by Burracoppin in the north-west, the Parker Range area (south of Southern Cross) in the east and Holleton (east of Narembeen) in the south, over a total linear range of *c.* 90 km east-west and *c.* 50 km north-south. This area is to the north of the distribution of subsp. *calycogona* (Figure 3). The new subspecies occurs in mallee and mixed mallee-mallet vegetation on pale orange to red clay-loams to thin stony loams with ironstone gravel. Associated eucalypts include *Eucalyptus capillosa* Brooker & Hopper, *E. celastroides* subsp. *celastroides, E. flocktoniae* (Maiden) Maiden subsp. *flocktoniae, E. moderata* L.A.S.Johnson & K.D.Hill, *E. neutra* D.Nicolle, *E. salmonophloia* F.Muell., *E. salubris* F.Muell., *E. sheathiana* Maiden, *E. subangusta* (Blakely) Brooker & Hopper subsp. *subangusta, E. tenera* L.A.S.Johnson & K.D.Hill, *E. tephroclada* L.A.S.Johnson & K.D.Hill and *E. yilgarnensis* (Maiden) Brooker.

Conservation status. Western populations occur in remnant roadside vegetation and in conservation reserves fragmented by agricultural land cleared for cropping, while eastern populations occur in largely uncleared areas but may be under threat from mining exploration and extraction activities, especially in the Marvel Loch area. The subspecies has been collected in conservation reserves to the south-east of Burracoppin.

Etymology. From the Latin *miraculum* (marvel), with two intended meanings; firstly referring to the prevalence of the subspecies in the Marvel Loch area, and secondly because we were somewhat surprised that the taxon went unrecognised and poorly collected until recently, despite its distinctiveness in the field and herbarium.

Notes. Eucalyptus calycogona subsp. *miracula* is distinguished within the species by its waxy branchlets, buds and fruits, the generally broader, dull adult leaves which are bluish at least when new, the consistently elliptical to ovate seedling leaves, and the generally larger flower buds and

Figure 1. Holotype of *Eucalyptus calycogona* subsp. *miracula* (*D. Nicolle* 4794 *& M.E. French*), scale = 5 cm.

Figure 2. Habit and habitat of *Eucalyptus calycogona* subsp. *miracula* (Dulyabin Road, south-west of Bodallin, 31° 36' 16" S, 118° 46' 05" E, *D. Nicolle* 4786 & *M.E. French*).

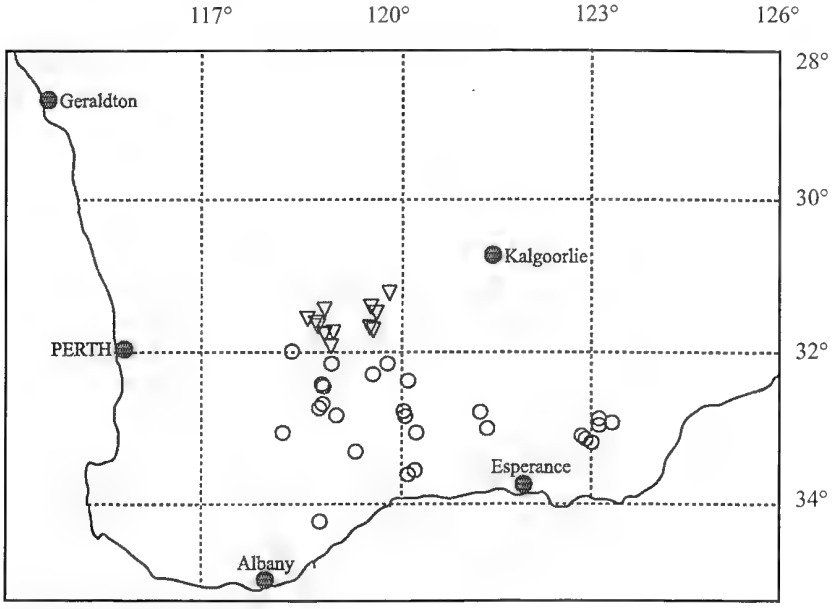

Figure 3. Distribution of *Eucalyptus calycogona* subsp. *calycogona* (○) and subsp. *miracula* (▽) in south-western Australia.

fruits. The new subspecies occurs to the north of the distribution of subsp. *calycogona*, and appears to form a geographical replacement pattern. Subspecific rather than specific status therefore seems appropriate. This is consistent with some other Western Australian mallee taxa which are distinguished by a similar suite of characters as subsp. *miracula* and form a geographical replacement pattern, such as *E. subangusta* Blakely subsp. *cerina* Brooker & Hopper (Brooker & Hopper 1991), *E. ebbanoensis* Maiden subsp. *glauciramula* K.D.Hill & L.A.S.Johnson (Hill & Johnson 1998) and *E. gittinsii* Brooker & Blaxell subsp. *illucida* D.Nicolle (Nicolle 2000b).

The Karalee populations of *E. calycogona* subsp. *miracula*, which represent the most north-easterly populations of the subspecies and are disjunct by approximately 40 km from the closest populations of the subspecies elsewhere (near Marvel Loch), are morphologically somewhat distinct, lacking distinctive wax on the branchlets, buds and fruits. They nevertheless have characteristics in common with subsp. *miracula* elsewhere, including the dull leaves, and have been tentatively included in subsp. *miracula* here.

Eucalyptus prolixa is partly sympatric with *E. calycogona* subsp. *miracula* in the south and east of the latter's distribution, although the two taxa appear to be ecologically separated, with *E. prolixa* occurring on more fertile, heavier soils and more often in mallet woodland vegetation communities. *Eucalyptus prolixa* is similarly partly sympatric with *E. calycogona* subsp. *calycogona* in the eastern part of the latter's Western Australian distribution, and again appears to be similarly ecologically separated. *Eucalyptus prolixa* is distinguished from *E. calycogona* in being a mallet and lacking a lignotuber (an obligate seeder, see Nicolle 2006), and also in its generally longer and more prominently four-ridged buds and fruits.

Acknowledgements

We are grateful to Ryonen Butcher and Skye Coffey at the Western Australian Herbarium for providing the scanned image of the holotype of the new subspecies, and to Ian Brooker for correcting the Latin diagnosis and commenting on the manuscript.

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A conspectus of the genus *Amaranthus* (Amaranthaceae) in Australia

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Abstract

Palmer, J. A conspectus of the genus *Amaranthus* L. (Amaranthaceae) in Australia. *Nuytsia* 19(1): 107–128 (2009). A synopsis of the 26 *Amaranthus* species known to occur in Australia is presented. *Amaranthus centralis* J.Palmer & Mowatt and *A. induratus* C.A.Gardner ex J.Palmer & Mowatt are described as new; distribution maps and photographs of the type specimens are included for these new species. *Amaranthus undulatus* R.Br. is the earliest correct name for the taxon currently known as *A. pallidiflorus* F.Muell., and lectotypes are selected for *A. clementii* Domin, *A. leptostachyus* Benth., *A. macrocarpus* Benth. and *A. mitchellii* Benth. A key to all species in Australia is presented.

Introduction

This paper is a precursor to the treatment of *Amaranthus* L. (Amaranthaceae) for the *Flora of Australia* series, presented in order to provide names for two new taxa, as well as typification and nomenclatural information required for ongoing revisionary work in the genus by other workers. This work is partly based on research initiated by the late Dr Andrew Kanis. Dr Kanis completed a very thorough literature search and resolved many nomenclatural problems before his untimely death, in addition to making extensive lists of specimens and type material held in both Australian and non-Australian herbaria. These lists and his other notes are retained at the Australian National Herbarium (CANB) and are the basis for the reference 'A. Kanis *in adnot.*' used in this paper.

The genus *Amaranthus* comprises up to 70 species worldwide, mostly in tropical and warm temperate regions. Many species are of economic importance as cultivated food crops or ornamentals, or as widespread weeds.

Brown (1810) was the first to describe indigenous *Amaranthus* taxa from Australia publishing four new species in his *Prodromus*. A further eight indigenous species were described by Mueller (1859), Bentham (1870), Domin (1921) and Black (1936). Since 1936, only one additional indigenous taxon has been noted, the informal *Amaranthus* sp. A from the Kimberley region of Western Australia (Wheeler 1992). This taxon is formally published here as *Amaranthus induratus* C.A.Gardener ex J.Palmer & Mowatt. The present treatment recognises 26 species of *Amaranthus* in Australia, comprising 11 indigenous, 14 naturalised and one introduced species.

Materials and methods

This study is based on the examination of herbarium specimens (reconstituted where necessary) held at AD, BM, BRI, CANB, DNA, HO, K, MEL, NSW, PERTH, PR and the private collection of the late A.C. Beauglehole, now incorporated in MEL. The fruit length measurements given here do not include the style and stigmas. Species names are arranged in alphabetical order.

Key to the species of *Amaranthus* in Australia

1. Inflorescences all or mainly axillary clusters, rarely also forming a very small leafless terminal spike or panicle
- **2.** Bracts and bracteoles 2.5–4 mm long, shortly aristate, pungent ..... **1. *A. albus**
- **2:** Bracts and bracteoles 1–3 mm long, mucronate to shortly aristate but not pungent
  - **3.** Fruit a circumcissile capsule
    - **4.** Tepals 3 in female flowers, ovate or narrowly ovate ..... **11. *A. graecizans**
    - **4:** Tepals 5 in female flowers, narrowly obovate to spathulate ..... **25. A. undulatus**
  - **3:** Fruit an indehiscent utricle
    - **5.** Fruit smooth to rugose, with prominent (rarely weak), longitudinal, straight ribs or inflated undulate ribs
      - **6.** Midnerve of tepals at the fruiting stage broad, 0.3–1 mm wide for some or all of length
        - **7.** Fruit 1.2–1.5 mm long, obovoid to globose; ribs inflated and undulate ..... **17. A. mitchellii**
        - **7:** Fruit 1.5–3 mm long, ellipsoid; ribs slightly raised, straight
          - **8.** Leaves linear to narrowly oblong or narrowly ovate; margins of tepals at the fruiting stage with a single or serrated tooth-like projection on each side ..... **14. A. induratus**
          - **8:** Leaves ovate or elliptic; margins of tepals at the fruiting stage without tooth-like projections ..... **4. A. centralis**
      - **6:** Midnerve of tepals at the fruiting stage narrow, *c.* 0.1 mm wide for entire length ..... **15. A. interruptus**
    - **5:** Fruit rugulose to rugose, without prominent, longitudinal, straight ribs or inflated undulate ribs
      - **9.** Fruit 3–5 mm long (rarely only 2mm long), ellipsoid
        - **10.** Tepals 5, 4–8 mm long; fruit slightly shorter than tepals ..... **12. A. grandiflorus**
        - **10:** Tepals 3 (rarely 4 or 5), to 3 mm long; fruit longer than tepal
          - **11.** Fruit black or dark brown ..... **16a. A. macrocarpus** var. **macrocarpus**
          - **11:** Fruit pallid or straw-coloured ..... **16b. A. macrocarpus** var. **pallidus**
      - **9:** Fruit 1–2.5 mm long, globose or obovoid
        - **12.** Tepals at the fruiting stage1.2–1.6 mm long (rarely to 2.3 mm long), spathulate; fruit usually equal to or longer than tepals ..... **6. A. cochleitepalus**
        - **12:** Tepals at the fruiting stage1.5–3 mm long, broadly spathulate, obovate-spathulate, rounded-obtrullate-spathulate, narrowly obovate-spathulate or narrowly obovate; fruit equal to or shorter than tepals
          - **13.** Tepals at the fruiting stage broadly spathulate, obovate-spathulate or rounded-obtrullate-spathulate, spreading to recurved ..... **8. A. cuspidifolius**
          - **13:** Tepals at the fruiting stage narrowly obovate-spathulate or narrowly obovate, usually erect ..... **15. A. interruptus**

1: Inflorescences mainly terminal, leafless, elongated spikes or panicles, although smaller spikes or axillary clusters may also be present
14. Leaf axils with paired spines 5–10 mm long. ..... **23. *A. spinosus**
14: Leaf axils without spines
15. Inflorescence pendulous, deep red to maroon or sometimes greenish ..... **3. *A. caudatus**
15: Inflorescence erect, various colours other than deep red to maroon (green but often tinged reddish in *A. cruentus*)
16. Fruit an indehiscent utricle
17. Tepals 5 in female flowers, or if 4, then bracts and bracteoles 1 mm long or longer
18. Fruit ellipsoid, smooth to rugose, longitudinally ribbed; tepals becoming hardened in fruit, with midnerve broad, 0.5–1 mm wide
19. Leaves linear to narrowly oblong or narrowly ovate; margins of tepals at the fruiting stage with a single entire or serrated tooth-like projection on each side ..... **14. A. induratus**
19: Leaves ovate or elliptic; margins of tepals of female flowers in fruit without tooth-like projections ..... **4. A. centralis**
18: Fruit globose or obovoid, rugulose to rugose, not or weakly ribbed; tepals remaining membranous in fruit, with midnerve narrow, 0.1–0.3 mm wide
20. Leaves ovate to trullate; stems sparsely hairy ..... **15. A. interruptus**
20: Leaves linear to narrowly elliptic; stems glabrous ..... **18. *A. muricatus**
17: Tepals 3 (rarely 2) in female flowers, or if 4, then bracts and bracteoles less than 1 mm long
21. Plants perennial, prostrate or decumbent, with stems hairy; fruit 2–3 mm long, distinctly longer than tepals ..... **9. *A. deflexus**
21: Plants annual, erect or prostrate, with stems more or less glabrous; fruit 1–2 mm long, equal to or slightly longer than tepals
22. Young stems glabrous, leaves usually deeply or broadly emarginate; fruit smooth or rugulose in the lower half ..... **2. *A. blitum**
22: Young stems sparsely hairy; leaves usually obtuse or shallowly emarginate; fruit rugose all over ..... **26. *A. viridis**
16: Fruit a circumscissile capsule
23. Bract and bracteoles shorter than or equal to tepals at the fruiting stage
24. Tepals of male and female flowers 3
25. Bracts and bracteoles <2 mm long, acute and mucronate; fruit globose ..... **22. A. rhombeus**
25: Bracts and bracteoles 2–3.5 mm long, acuminate and aristate; fruit broadly ovoid or ellipsoid
26. Tepals at the fruiting stage1.5–2.5 mm long, ovate-oblong to oblong-spathulate, acute, mucronate ..... **10. *A. dubius**
26: Tepals at the fruiting stage 2.5–4 mm long, narrowly ovate to narrowly elliptic, acuminate, aristate ..... **24. *A. tricolor**
24: Tepals of male and female flowers 4 or 5
27. Leaves narrowly ovate; midnerve of tepals at the fruting stage broad, 0.5–0.8 mm wide ..... **5. A. clementii**
27: Leaves ovate to broadly ovate or rhombic to trullate or elliptic to circular; midnerve of tepals at the fruiting stage narrow, 0.1 mm wide
28. Lamina of mature leaves 5–45 mm long, 4–30 mm wide; tepals at the fruiting stage narrowly obovate to spathulate, often recurved ..... **25. A. undulatus**
28: Lamina of mature leaves 30–120 mm long, 20–80 mm wide; tepals at the fruiting stage ovate-oblong or oblong-spathulate, erect ..... **10. *A. dubius**
23: Bract and bracteoles longer than tepals at the fruiting stage
29. Young stems and inflorescences sparsely to densely hairy, tepals obtuse or emarginate ..... **21. *A. retroflexus**

29: Young stems and inflorescences glabrous to sparsely hairy; tepals acute or acuminate
30. Bracts and bracteoles 2–3 mm long, erect
31. Spikes greenish, usually 4–7 mm wide; fruit slightly shorter than or equal to tepals ..... **13. *A. hybridus**
31: Spikes green but often tinged reddish, 7–12 mm wide; fruit equal to or longer than tepals ..... **7. *A. cruentus**
30: Bracts and bracteoles 3.5–6 mm long, or if <3.5 mm long then spreading to recurved
32. Tepals of female flowers 5, at the fruiting stage often spreading to recurved or erect, unequal, longest tepal up to 2.5 mm long; fruit *c.* 1.5 mm long ..... **20. *A. quitensis**
32: Tepals of female flowers 3–5, at the fruiting stage erect, unequal, longest tepal 2.5–4 mm long; fruit 2–2.5 mm long ..... **19. *A. powellii**

Conspectus of Australian *Amaranthus* taxa

1. *Amaranthus albus L., *Syst. Nat.* 10th edn, 2: 1268 (1759). *Type*: 'Habitat [in Philadelphiae maritimus]' Herb. C. Linnaeus 1117.1 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* T. Raus in A. Strid & K. Tan (eds), *Fl. Hellenica* 1: 143, 1997).

Distribution. Native to North America, naturalised in South America, Eurasia, Africa and Australia. In Australia a weed of the wheatbelt of south-western Western Australia and roadsides and disturbed areas in South Australia, New South Wales, the Australian Capital Territory, Victoria and Tasmania.

2. *Amaranthus blitum L., *Sp. Pl.* 2: 990 (1753). *Type*: 'Habitat in Europa temperatoire', Herb. C. Linnaeus 1117.14 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* F. Fillias *et al.*, *Taxon* 29: 150, 1980).

Amaranthus lividus L., *Sp. Pl.* 2: 990 (1753). *Type*: 'Habitat in Virginia', not designated.

Amaranthus oleraceus L., *Sp. Pl.* 2nd edn, 2: 1403 (1763); *Amaranthus blitum* var. *oleraceus* (L.) Hook.f., *Flora Brit. India* 4: 721 (1885). *Type*: 'Habitat in India', Herb. C. Linnaeus 1117.13 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* F. Fillias *et al.*, *Taxon* 29: 150, 1980).

Amaranthus ascendens Loisel., *Not. Fl. France* 141 (1810); *Amaranthus lividus* var. *ascendens* (Loisel.) Hayward & Druce, *Adventive Fl. Tweedside* 177 (1919); *Amaranthus lividus* subsp. *ascendens* (Loisel.) Heukels, *Geill. Schoolfl. voor Nederl.* 11th edn, 169 (1934). *Type*: J.J. Bauhin, *Hist. Pl.* 2: 966, fig. 'Blitum pulchrum rectum magnum rubrum' (1651) (*lecto*: *n.v.*, *fide* C.C. Townsend in R.M. Polhill (ed.), *Fl. Trop. E. Africa, Amaranthaceae* 35, 1985).

[*Amaranthus viridis auct. non* L.: J.H. Maiden, *Proc. Linn. Soc. New South Wales* 28: 766 (1904); A.N. Rodd & J. Pickard, *Cunninghamia* 1: 275 (1983).]

Distribution. Probably native to Europe, also occurs in Africa, America, Asia and Malaysia. In Australia it is a weed of disturbed sites around Perth in Western Australia, Brisbane and surrounds, islands in the Torres Strait in Queensland, and Sydney in New South Wales. Also recorded from Norfolk and Lord Howe Islands (Green 1994).

3. *Amaranthus caudatus L., *Sp. Pl.* 2: 990 (1753). *Type*: 'Habitat in Peru, Persia, Zeylonia', Herb. C. Linnaeus 1117.26 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* C.C. Townsend in E. Nasir & S.I. Ali (eds), *Fl. W. Pakistan* 71: 10, 1974).

Distribution. Native to South America, now widespread and commonly cultivated as a garden ornamental. In Australia it is an occasional garden escape in Western Australia, the Northern Territory, South Australia, Queensland, New South Wales and the Australian Capital Territory.

4. Amaranthus centralis J.Palmer & Mowatt, *sp. nov.*

Ab *Amarantho indurato* foliis ellipticus vel ovatis, bracteis bracteolisque acuminatis mucronatis, tepalis florum masculorum anguste ovatis acuminatis, et tepalis fructificantibus florum femineorum dentes laterales marginales deficientibus differt. Ab *A. mitchellii* inflorescentiis terminalibus axillaribusque et fructibus majoribus ellipsoideis (1.5–3 mm longis), costis arrectis longitudinalibus plus minusve tuberculatis differt.

Typus: Todd River, *c.* 9.6 km N Alice Springs, Northern Territory, 10 November 1954, *G. Chippendale* 482 (*holo*: DNA; *iso*: CANB).

Amaranthus sp. Todd River (G. Chippendale 482) J. Palmer, in W.R. Barker *et al.* (eds), *Census of South Australian Vascular Plants* 5th ed., *J. Adelaide Bot. Gard. Supplement* 1: 46 (2005).

Amaranthus sp. Alice Springs (D.E. Albrecht 8892), in R.A. Kerrigan & D.E. Albrecht (eds), *Checklist of NT vascular Plant Species* p. 14 (2007).

Amaranthus sp. Cloncurry (S.T. Blake 8896), in P.D. Bostock & A.E. Holland (eds), *Census Queensland Fl. 2007* p. 15 (2007).

Annual herb, erect, to 60 cm high. *Stems* angular, sometimes reddish, sparsely hairy with glandular or multicellular hairs or becoming glabrous; leaf axils spineless. *Leaves*: petiole 2–20(–35) mm long; lamina elliptic or ovate, 6–35(–55) mm long, 4–17(–25) mm wide, ±undulate, obtuse to emarginate, mucronate, glabrous or sometimes very sparsely hairy on midnerve. *Inflorescences* of axillary globular clusters and sometimes erect terminal spikes to 60 mm long, with male and female flowers. *Bract* 1, persistent, ovate, 1.2–1.8 mm long, shorter than the tepals, acuminate, mucronate. *Bracteoles* 2, persistent, ovate, 1.2–1.8 mm long, shorter than the tepals, acuminate, mucronate. *Tepals* 5; *tepals of male flowers* elliptic to narrowly obovate, 1.5–2 mm long, obtuse to acute, mucronate, margins membranous, whitish, glabrous, midnerve narrow, *c.* 0.1 mm wide, green; *tepals of female flowers* narrowly obovate-spathulate to obovate-spathulate or spathulate, 2–4 mm long, obtuse, mucronate, erect to recurved, margins membranous, entire, glandular-hairy along some or all of length, midnerve broad, 0.6–1 mm wide, green; *tepals at the fruiting stage* becoming hardened in the lower part and often sigmoid in outline, becoming dark green to brown or straw-coloured, margins remaining entire, falling with fruit. *Stamens* 3, *c.* 1–1.8 mm long; filaments free; anthers 2-locular, dorsifixed, versatile, dehiscing by extrorse longitudinal slits, 0.5–0.9 mm long. *Ovary* sessile; ovule 1; style *c.* 0.5 mm long; stigmas 3, erect to recurved, somewhat inflated. *Fruit* an indehiscent utricle, ellipsoid, 1.5–3 mm long, shorter than tepals, slightly rugose, usually ribbed; ribs slightly raised, straight, longitudinal, slightly tuberculate. *Seed* obovoid to broad-obovoid, 1.2–1.4 mm long, smooth, reddish-brown to black, shiny. (Figures 1, 2A)

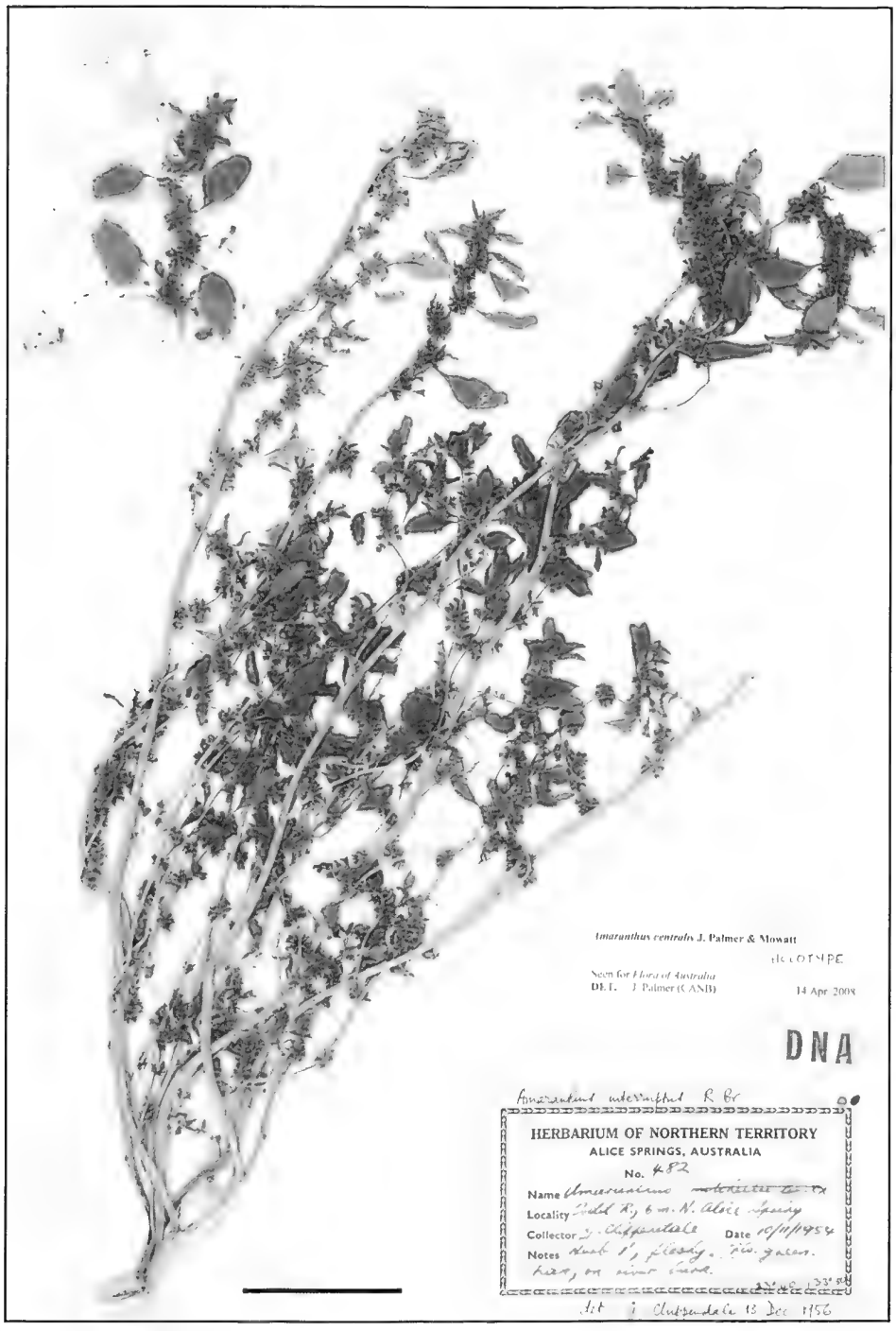

Figure 1. Holotype of *Amaranthus centralis* (*G. Chippendale* 482, DNA), scale = 5 cm.

Figure 2. A – tepals at the fruiting stage of *Amaranthus centralis* (*G. Chippendale* 482), scale = 1 mm; B – tepals at the fruiting stage of *A. induratus* (*K.M. Allan* 587), arrows indicating single or serrated tooth-like projections on tepal margins, scale = 1 mm.

Other specimens examined. WESTERN AUSTRALIA: Marra Mamba, Hamersley Range, 5 July 1966, *J.V. Blockley* 302 *p.p.* (PERTH 200476); 57 km NW of Newman, Fortescue River, 17 July 2001, *P.K. Latz* 18500 (NT *n.v.*, photo at CANB, PERTH *n.v.*, photo at CANB); 8.6 km E of Mt Bruce, 5.2 km S of Mt Oxer, 5.7 km NW of Mt Howieson, Mt Bruce Flats, Hamersley Range, Karijini National Park, 18 May 1992, *S. van Leeuwen* 1214 (PERTH). NORTHERN TERRITORY: Palm Valley, 7 July 1965, *A.C. Beauglehole* 10388 (DNA); Ruby Gorge, Hale River, *c.* 70 miles [*c.*112 km] ENE of Alice Springs, 14 Oct. 1966, *A.C. Beauglehole* 20749 (DNA); vicinity of Mt Gillen, Alice Springs, 21 Sep. 1955, *N.T. Burbidge & M. Gray* 4238 (CANB); MacDonald Downs, 25 Oct. 1974, *P.K. Latz* 7871 (DNA); Simpsons Gap, Alice Springs, 27 Feb. 1961, *H.S. McKee* 8644 (CANB, NSW); east side, Alice Springs, 6 May 1964, *D.J. Nelson* 1005 (CANB, DNA); Animal Industry Research Farm, 9.7 km S of Alice Springs, 19 Nov. 1971, *D.J. Nelson* 2168 (CANB, DNA); Parke Creek, E end of Mereenie oil field, 9 Mar. 1983, *A.S. Weston* 13428 (DNA); 8 miles [*c.* 13 km] E Mt Riddock, 2 Oct. 1954, *R.E. Winkworth* 607 (DNA). SOUTH AUSTRALIA: 30 km W of Mimili, Everard Ranges, 17 May 1983, *R. Bates* 2940 (AD); Barrarana Gorge, Flinders Ranges, 23 Apr. 1996, *R. Bates* 42953 (CANB); 'Nilpinna', Nilpinna Hill, W of Lake Eyre, 15 Apr. 1997, *R. Bates* 46903 (CANB); Brachina Creek, Flinders Ranges, 13 July 1998, *R. Bates* 50637 (CANB); near Betty's Well, Everard Park Station, Everard Ranges, Feb. 1965, *D.E. Symon* 3337 (AD, CANB); Ernabella, 1 Apr. 1964, *F.T. Turvey s.n.* (CBG 13742 at CANB). QUEENSLAND: about 87 km W of Betoota, 18 May 1988, *K.P. Nicholson* 209 *& P.E. Novelly* (BRI); Cloncurry, 10 May 1935, *S.T. Blake* 8896 (BRI).

Distribution and habitat. Commonly occurs in southern Northern Territory, and from the Everard Ranges near Lake Eyre south to the Flinders Ranges in northern South Australia. There are also two records from the Pilbara region of Western Australia, and two collections from western Queensland.

Amaranthus centralis grows in red sand in ephemeral watercourses, sandy to clayey loam on river banks and edges of permanent pools in eucalypt lined channels, or *Acacia* shrubland. It also occurs in areas of permanent watering, e.g. bore overflows, gardens and cultivation. (Figure 3)

Phenology. Flowers and fruits throughout the year.

Etymology. The epithet reflects the central Australian distribution of this taxon.

Notes. *Amaranthus centralis* is most similar to *A. induratus*, but that species has dense or interrupted terminal and axillary inflorescences (axillary globular clusters and sometimes terminal spikes in *A. centralis*), linear to very narrowly oblong or narrowly ovate leaves (elliptic or ovate in *A. centralis*) and the tepals at the fruiting stage are toothed along the margins (entire in *A. centralis*; Figure 2). *Amaranthus centralis* is also similar to *A. mitchellii* and *A. cuspidifolius*, but these species have spathulate to broadly spathulate tepals in female flowers (narrowly obovate-spathulate to obovate-spathulate or spathulate in *A. centralis*) and smaller, rugose utricles that are either unribbed or with prominent undulate ribs (slightly rugose and usually with slightly raised straight ribs in *A. centralis*). Several mixed collections of *A. centralis* and *A. cuspidifolius* from northern South Australia suggest that these two species often grow together.

5. Amaranthus clementii Domin, *Biblioth. Bot.* 89: 76 (1921). *Type*: between the Ashburton and De Grey Rivers, NW Australia, [Western Australia], purchased Aug. 1900, *E. Clement s.n.* (in Herb. Domin 3793) (*lecto*: PR 526421, here designated, photo at CANB; *isolecto*: K, 2 sheets *n.v.*, photos at CANB).

?*Amaranthus pallidiflorus* var. *viridiflorus* Thell. in R. Probst, *Mitt. Naturf. Ges. Solothurn* 20(8): 60 (1928). *Type*: *n.v.*

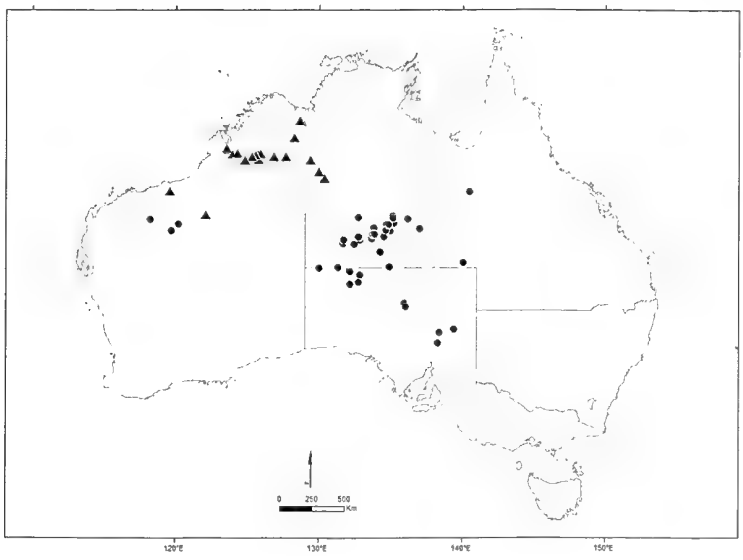

Figure 3. Distribution map for *Amaranthus centralis* (●) and *A. induratus* (▲).

Distribution. Endemic to the Pilbara region of Western Australia along the coast including some offshore islands, and inland from Port Hedland south to the Murchison River. Also recorded from Rudall River National Park in the Little Sandy Desert.

Typification. The lectotype was originally chosen by A. Kanis while on a visit to PR in May 1976. There are two sheets at PR: 'inter flumina Ashburton and De Grey River, W.A., viii 1900, *E. Clement s.n.* (in Herb. Domin 3791), PR 526419' and 'between the Ashburton and De Grey River, NW Australia, purchased Aug. 1900, *E. Clement s.n.* (in Herb. Domin 3793), PR 526421'. Kanis chose PR 526421 as the type, annotating PR 526419 with 'This material is not fully conform [*sic*] the description as a terminal inflorescence is clearly developed here and some leaves are larger'. Subsequent additional collections of *A. clementii* indicate that this material is indeed representative of the species, which can develop a terminal inflorescence and has variably-sized leaves. Accordingly, this sheet (PR 526419) is here considered part of the original material.

6. Amaranthus cochleitepalus Domin, *Biblioth. Bot.* 89: 80 (1921). *Type*: Pentland, Queensland, February 1910, *K. Domin s.n.* (*holo*: PR 526427, photo at CANB).

Amaranthus sp. B *sensu* J.R. Wheeler (ed.), *Fl. Kimberley Region* 113 (1992).

Amaranthus sp. B. Kimberley Flora (R.D. Royce 3324), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 17 October 2007].

Distribution. Occurs near Port Hedland in the Pilbara region (also known from one locality in the Kimberley region) of Western Australia, on the Barkly Tableland and south towards Alice Springs in the Northern Territory, and Camooweal, south of the Gulf of Carpentaria and near Clermont in Queensland.

Notes. Specimens apparently intermediate between *Amaranthus cochleitepalus*, *A. cuspidifolius* and *A. mitchellii* have been seen. See notes under *A. mitchellii* for further details.

7. * Amaranthus cruentus L., *Syst. Nat.* 10th edn, 2: 1269 (1759); *Amaranthus paniculatus* var. *cruentus* (L.) Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 257 (1849); *Amaranthus hybridus* subsp. *cruentus* (L.) Thell., *Fl. Adv. Montpellier* 205 (1912); *A. hybridus* var. *cruentus* Mansf. *Die Kulturefianzen* 2: 54 (1959). *Type*: 'Habitat in China', Herb. C. Linnaeus 1117.25 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* C.C. Townsend in E. Nasir & S.I. Ali (eds), *Fl. W. Pakistan* 71: 12, 1974).

Amaranthus paniculatus L., *Sp. Pl.* 2nd edn, 2: 1406 (1763). *Type*: 'Habitat in America', Herb. C. Linnaeus 1117.20 (*lecto*: LINN *n.v.* [IDC microfiche seen] ,*fide* M.N. El Hadidi & A.M.H. El Hadidy, *Taeckholmia, Addit. Ser.* 1: 37, 1981).

Distribution. Probably originated as a grain crop in southern Mexico or Guatemala but widely grown as a dye plant, ornamental and pot-herb in Central America, Europe, China, India, south-east Asia, and Africa. In Australia recorded as an uncommon weed mainly occurring spontaneously in gardens and disturbed areas around Perth in Western Australia, and in South Australia, New South Wales and Victoria.

8. Amaranthus cuspidifolius Domin, *Biblioth. Bot.* 89: 78 (1921). *Type*: between the Ashburton and De Grey Rivers, NW Australia, [Western Australia], purchased Aug. 1900, *E. Clement s.n.* (*holo*: PR 526426, photo at CANB).

Distribution. Occurs in the Pilbara region of Western Australia, east into the Sandy and Gibson Deserts and ranges of the southern Northern Territory, in northern South Australia south to Oodnadatta and the Flinders Ranges, on Nappa Merri Station in south-western Queensland, and near Broken Hill and Louth in western New South Wales.

Notes. Specimens apparently intermediate between *Amaranthus cuspidifolius*, *A. mitchellii* and *A. ochleitepalus* have been seen. See *Notes* under *A. mitchellii* for further details.

9. *Amaranthus deflexus L., *Mant. Pl. Altera* 295 (1771). *Type*: Cultivated specimen from Uppsala Botanic Garden, Herb. C. Linnaeus 1117.18 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* P. Aellen in K.H. Rechinger (ed.), *Fl. Iranica* 91: 7, 1972).

Distribution. Native to South America and now naturalised in North America, the Mediterranean and Australia. In Australia it is an occasional weed of disturbed ground in South Australia, New South Wales, Victoria and Tasmania.

10. *Amaranthus dubius Mart. ex Thell., *Fl. Adv. Montpellier* 203 (1912). *Type*: cultivated material from Erlangen Botanic Garden, ex Herb.. Schwaegrichen (*neo*: M *n.v.*, *fide* C.C. Townsend, *Kew Bull.* 29(3): 471–472, 1974).

Distribution. An annual weed with a pantropical distribution, *A. dubius* is commonly grown as a leafy vegetable in south-east Asia (Grubben 1993), and is also widely cultivated and naturalised in Papua New Guinea, Timor and Indonesia, with a single record from Christmas Island (Barker 1993). Grown as a vegetable on Horn and Thursday Islands in the Torres Strait, and also available from vegetable markets in northern Australia (B.M. Waterhouse, pers. comm. 1999). Not known to be established in Australia, but recorded from Nhulunbuy, Northern Territory (*A.A. Mitchell* 5601, CANB) as an infrequent inhabitant at the local rubbish tip and from Cooktown, Queensland (*Hornby s.n.*, CANB 739005) as a single plant 'grown from mulch obtained from banks of Endeavour River'.

11. *Amaranthus graecizans L., *Sp. Pl.* 2: 990 (1753). *Amaranthus angustifolius* Lam., *Encycl. Meth.* 1: 115 (1783), *nom. illeg. Type:* 'Habitat in Virginia', *Clayton* 442 (*lecto*: BM 000051563 *n.v.*, *fide* M.L. Fernald, *Rhodora* 47: 139, pl. 887, 1945).

11a. *Amaranthus graecizans subsp. **silvestris** (Vill.) Brenan, *Watsonia* 4: 273 (1961), as *sylvestris; Amaranthus silvestris* Vill., *Cat. Pl. Jard. Strasbourg* 111 (1807); *Amaranthus graecizans* var. *silvestris* (Vill.) Asch., *Beitrage zur Flora Aethiopiens* 1: 176 (1867), as *silvester*; *Amaranthus angustifolius* var. *silvestris* (Vill.) Thell. in H. Schinz & R. Keller, *Fl. Schweiz* 4th edn, 1: 222 (1923), as *Amarantus*; *Amaranthus angustifolius* subsp. *silvestris* (Vill.) Heukels, *Geill. Schoolfl. voor Nederl.* (1934). *Type*: Herb. Tournefort 1849 (*lecto*: P *n.v.* [IDC microfiche 90.19], *fide* C.C. Townsend in R.M. Polhill (ed.), *Fl. Trop. E. Africa, Amaranthaceae* 31, 1985).

Distribution. Native to southern Europe, northern Africa and western Asia, although now widely naturalised. In Australia it is naturalised around Adelaide in South Australia, near Biloela in Queensland and at Inglewood and Casterton in Victoria.

12. Amaranthus grandiflorus (J.M. Black) J.M. Black, *Trans. & Proc. Roy. Soc. South Australia* 60: 166 (1936); *Amaranthus mitchellii* var. *grandiflorus* J.M. Black, *Trans. & Proc. Roy. Soc. South Australia* 47: 368 (1923). *Type*: Depot Creek, 10 June 1883, Herb. R. Tate *s.n.* (*holo*: AD 99436234).

Distribution. Occurs from the southern Northern Territory into the Lake Eyre region and scattered sites southwards in South Australia, south-western Queensland, western New South Wales and in the Hattah Lakes area in north-western Victoria.

13. *Amaranthus hybridus L., *Sp. Pl.* 2: 990 (1753). *Type*: 'Habitat in Virginia', Herb. C. Linnaeus 1117.19 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* C.C. Townsend in E. Nasir & S.I. Ali (eds), *Fl. W. Pakistan* 71: 19, 1974).

Amaranthus chlorostachys Willd., *Hist. Amaranth.* 34, t. X, fig. 19 (1790). *Type*: illustration in C.L. Willdenow, *Hist. Amaranth.* 34, t. X, fig. 19 (1790).

Amaranthus patulus Bertol., *Comm. Neap.* 19, t. 2 (1837). *Type*: Italy, Naples, 1834, *Bertoloni s.n.* (*holo*: BOLO *n.v., fide* C.C. Townsend in R.M. Polhill (ed.), *Fl. Trop. E. Africa, Amaranthaceae* 25, 1985).

Distribution. Native of North America, now widespread as a weed in the temperate regions of the world. In Australia it is a weed of cultivation and disturbed areas in south-western Western Australia, the Northern Territory, South Australia, Queensland, New South Wales, the Australian Capital Territory and Victoria. Also occurs on Christmas Island (Barker 1993).

14. Amaranthus induratus C.A.Gardner ex J.Palmer & Mowatt, *sp. nov.*

Ab *Amarantho centrali* foliis anguste oblongis vel anguste ovatis bracteis bracteolisque acutis, tepalis florum masculorum anguste ellipticus vel obovatis obtusis, et praesentia dentium lateralium in marginibus tepalorum fructificantium differt. Ab *A. undulato* et *A. clementii* fructibus costatis ellipsoideis indehiscentibus differt.

Typus: 43 miles [*c.* 69 km] S of Derby at river crossing, Western Australia, 25 January 1971, *K.M. Allan* 587 (*holo*: PERTH 00205869; *iso*: CANB).

Amaranthus sp. A. *sensu* J.R. Wheeler (ed.), *Fl. Kimberley Region* p. 111, fig. 27J (1992).

Amaranthus sp. A. Kimberley Flora (C.A. Gardner *s.n.* PERTH 00326518), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 17 October 2007].

Amaranthus sp. Birrindudu (J.L. Egan 4244), in R.A. Kerrigan. & D.E. Albrecht (eds), *Checklist of NT Vascular Plant Species* p. 4 (2005).

Annual herb, erect, up to 90 cm high. *Stems* rounded, sparsely hairy with glandular or multicellular hairs or becoming glabrous, leaf axils spineless. *Leaves*: petiole to 25 mm long; lamina linear to very narrowly oblong or narrowly ovate, 15–70 mm long, 2–10 mm wide, obtuse to emarginate, mucronate. *Inflorescences* of axillary globose clusters and axillary and terminal erect, dense or interrupted spikes to 23 cm long, sometimes forming panicles, predominantly female-flowered. *Bract* 1, persistent, ovate,

c. 1 mm long, shorter than the tepals, acute. *Bracteoles* 2, persistent, ovate, *c.* 1 mm long, shorter than the tepals, acute. *Tepals* 5; *tepals of male flowers* narrowly elliptic to obovate, *c.* 1.5 mm long, obtuse, margins membranous, whitish, glabrous, midnerve narrow, 0.1 mm wide, green; *tepals of female flowers* obovate-spathulate, 1.5–2.4 mm long, obtuse, ±mucronulate, erect or recurved, margins entire, membranous, whitish, glabrous or with sparse glandular hairs along the margins in the lower half, midnerve broad, 0.5–1 mm wide, green; *tepals at the fruiting stage* becoming elongated, 2.4–3.5 mm long, obovate-spathulate or narrowly obovate-spathulate, hardened, green to straw-coloured, margins developing a single entire or serrated tooth-like projection on each side below the middle, falling with fruit. *Stamens* 3, 0.8–1.2 mm long; filaments free; anthers 2-locular, dorsifixed, versatile, dehiscing by extrorse longitudinal slits, 0.6–0.9 mm long. *Ovary* sessile; ovule 1; style and stigmas up to 1 mm long, often inflated; stigmas 3, erect to recurved. *Fruit* an indehiscent utricle, ellipsoid, 1.5–3 mm long, slightly shorter than tepals, smooth to rugulose, ribbed; ribs slightly raised, straight, longitudinal, tuberculate. *Seed* obovoid, 1.3–1.5 mm long, smooth, reddish-black, shiny. (Figures 2B, 4)

Other specimens examined. WESTERN AUSTRALIA: near Warralong Homestead, May 1941, *N.T. Burbidge* 726 (PERTH); Halls Creek township, 12 July 1974, *G.W. Carr* 3512 *& A.C. Beauglehole* 47290 (AD, CANB, MEL); Geikie Gorge National Park, 17 July 1974, *G.W. Carr* 3812 *& A.C. Beauglehole* 47590 (AD, CANB, MEL); Hill near Fitzroy Crossing, Apr. 1927, *A.J. Ewart s.n.* (PERTH 00201693); Gogo, Fitzroy River, Apr. 1951, *C.A. Gardner s.n.* (PERTH 00326518); Carlton Reach Experimental Plots, Ord River, 29 May 1944, *C.A. Gardner* 7306 (PERTH); bank of Fitzroy River at Fitzroy Crossing, 28 May 1967, *E.N.S. Jackson* 993 (AD, DNA); Rudall River Region, Sep. 1986, *W.G. Martinick & Associates* 135 (PERTH 1218581); Old Wyndham Road, 5.63 km from Kununurra on a bearing of 77°, 28 Apr. 1999, *A.A. Mitchell* 5749 (CANB); Margaret River Downs, Apr. 1944, *Captain Montgomery s.n.* (MEL 59695, PERTH 00265950); 203 miles [325 km] E of Derby on Halls Creek road, 28 Apr. 1967, *Y. Power* 408 (PERTH); Mt Anderson Stn, Fitzroy River, 7 May 1962, *R.D. Royce* 6904 (CANB, PERTH); Camballan [Camballin], Fitzroy River, 8 May 1962, *R.D. Royce* 6929 (PERTH); Bow River Station turn-off, 15 miles [24 km] N of Turkey Creek, 20 June 1967, *D.E. Symon* 5267 (AD); 32 miles [51 km] SW of Mary River crossing, 22 June 1967, *D.E. Symon* 5287 (AD, CANB, PERTH); 43 miles [68 km] E of Fitzroy Crossing, 22 June 1967, *D.E. Symon* 5297 (AD, PERTH 00239968); 29 km W of Fitzroy Crossing, 21 May 1971, *D.E. Symon* 6985 (CANB, PERTH). NORTHERN TERRITORY: Birrindudu Stn, 19 June 1994, *J.E. Egan* 4244 (DNA *n.v.*, photo at CANB); west of Spyder Lake, 29 Apr. 2004, *D.L. Lewis* 14 *& D.J. Dixon* (DNA *n.v.*, photo at CANB); 11 km NE of Wilson Ck bore, *c.* 90 km NE of Tanami, 17 May 1971, *D.E. Symon* 6918 (DNA).

Distribution and habitat. Occurs in Western Australia, along the Ord and Fitzroy Rivers in the Kimberley region, south-west into the Rudall River area and Warralong Homestead in the Pilbara region. Also recorded from the Tanami Desert area of the Northern Territory. (Figure 3) Grows in red clay or loam along watercourses or near clay pans, with *Acacia* and *Bauhinia* spp. It has also been recorded from cultivated areas in the vicinity of the Ord River, Western Australia.

Phenology. Flowers mainly April to July but has also been recorded as flowering in January, February and September.

Etymology. A manuscript name coined by C.A. Gardner most likely referring to the tepals which become hardened or indurated in fruit.

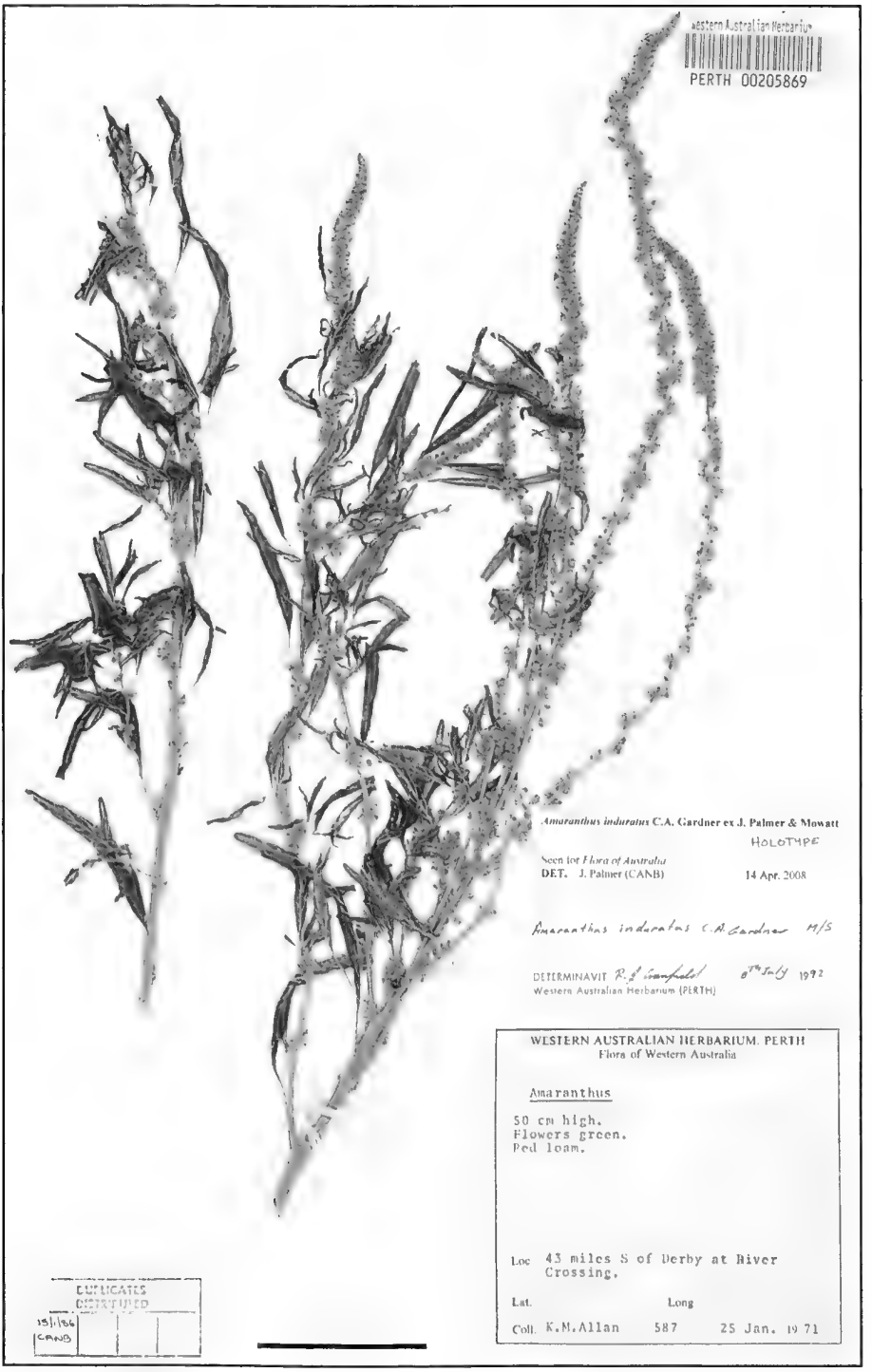

Figure 4. Holotype of *Amaranthus induratus* (*K.M. Allan* 587, PERTH), scale = 5 cm.

Notes. Amaranthus induratus is probably most closely related to *A. centralis*, but that species has elliptic or ovate leaves (linear to very narrowly oblong or narrowly ovate in *A. induratus*) and the tepals at the fruiting stage lack tooth-like projections (toothed in *A. induratus*; Figure 2). *Amaranthus induratus* is also similar to *A. mitchellii* but that species differs in having inflorescences of mostly axillary clusters (axillary globose clusters and dense or interrupted terminal spikes in *A. induratus*), shorter, ovate or narrowly ovate to oblong leaves (longer, linear to very narrowly oblong or narrowly ovate in *A. induratus*), tepals at the fruiting stage that lack teeth (tepal margins toothed in *A. induratus*) and obovoid to globose fruit that are rugose with inflated undulate ribs (ellipsoid fruit that are smooth to rugulose with slightly raised, straight, longitudinal, tuberculate ribs in *A. induratus*).

One specimen (*Martinick & Associates* 135, PERTH 01218581) from the Rudall River region, Western Australia, differs slightly in that the tepals at the fruiting stage have entire margins or sometimes extremely reduced tooth-like projections, but in all other respects the material matches *A. induratus*.

15. Amaranthus interruptus R.Br., *Prodr.* 414 (1810); *Euxolus interruptus* (R.Br.) Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 267, 275 (1849). *Type*: tropical areas of Northern Territory and Queensland, 'North Coast', *R. Brown, Iter Australiense 3048* (*holo*: BM 000847081 *n.v.*, photo at CANB; *iso*: K 000356720 *n.v.*, photo at CANB).

Amaranthus lineatus R.Br., *Prodr.* 414 (1810); *Euxolus lineatus* (R. Br.) Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 267, 276 (1849). *Type*: tropical areas of Northern Territory and Queensland, 'North Coast', *R. Brown, Iter Australiense 3049* (*holo*: BM 000884578 *n.v.*, photo at CANB; *iso*: K 000356721 *n.v.*, photo at CANB).

[*Amaranthus crispus auct. non* (Lesp. & Thévenau) A.Braun ex J.M.Coult. & S.Watson, Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 17 October 2008)].

Distribution. Recorded from Kununurra, the Ord River and Bungle Bungle National Park in the Kimberley region of Western Australia. Common on the Barkly Tableland and to the south in the Northern Territory, eastwards into Queensland and then scattered further south into the Musgrave Ranges and northern Flinders Ranges, South Australia. Also occurs on the coral cays of Ashmore Reef in Western Australia, where it was previously erroneously identified as *Amaranthus crispus* (Lesp. & Theven.) Terracc., and on Raine Island off the east coast of Queensland. Backer (1949) records it from Timor and New Guinea; this material may represent introductions (Kanis 1978).

16. Amaranthus macrocarpus Benth., *Fl. Austral.* 5: 216 (1870), as *Amarantus*; *Euxolus macrocarpus* (Benth.) F. Muell., *Native Pl. Victoria* 1: 161 (1879). *Type*: junction of the Murray & Darling, New South Wales, Dec. 1853, *F. Mueller s.n.* (*lecto*: MEL 59717 here designated; *isolecto*: MEL 59716, K *p.p.* (left-hand side specimens) *n.v.*, photo at CANB, NSW 16811).

Typification. Bentham (1870) cites several collections in the protologue, from Queensland: Armadilla, *W. Barton* 14 (MEL 59715); Dawson River, *Leichhardt* 304 (MEL 59714); and New South Wales: junction of the Murray & Darling, *F. Mueller s.n.* (MEL 59717, MEL 59716, K p.p., NSW 16811); Darling River, *?Woolls s.n.* (MEL 59718) [Woolls is not listed on the label, but the corner has been initialled with a 'B' indicating that Bentham has seen it]. Mueller's collection at MEL (MEL 59717) has been chosen as the lectotype as this gathering is the most widely distributed. The right-hand specimen of the K collection, collected by *F.C. Dalton*, is an isotype of *A. macrocarpus* var. *pallidus* Benth.

16a. Amaranthus macrocarpus Benth. var. **macrocarpus.** *Amaranthus macrocarpus* Benth. var. *melanocarpus* Thell. in P.F.A. Ascherson & K.R.O.P.P. Graebner, *Synopsis der Mitteleuropaischen Flora* 5(1): 311 (1914), *nom. inval.*

Distribution. Occurs from near Emerald in central Queensland south into northern Victoria, and scattered localities in the southern and eastern Northern Territory and eastern South Australia. Also recorded as a weed at Flemington Saleyards in Sydney and Tamworth Agricultural Research Centre in New South Wales, and in several Victorian towns along the Murray River.

16b. Amaranthus macrocarpus var. **pallidus** Benth., *Fl. Austral.* 5: 216 (1870). *Type*: Curriwillighie [Currawillinghi], Queensland, *s. dat., F.C. Dalton s.n.* (*holo*: MEL 59713; iso: K *p.p.* (right-hand side specimen) *n.v.*, photo at CANB).

Distribution. Occurs near Macalister and Noondoo in southern Queensland, around Brewarrina, Walgett and Inverell in northern NSW, and in south-eastern South Australia.

17. Amaranthus mitchellii Benth., *Fl. Austral.* 5: 214 (1870), as *Amarantus*; *Euxolus mitchellii* (Benth.) F. Muell. in E. Giles, *Geog. Cent. Aust.* 214 (1875), as *Mitchelli*; *Amaranthus mitchellii* var. *typicus* Domin, *Biblioth. Bot.* 89: 78 (1921), *nom. inval. Type*: Narran River, [probably New South Wales], 24 Mar. 1846, *T.L. Mitchell s.n.* (*lecto*: K 000356723 *n.v.*, here designated, photo at CANB; *isolecto*: BM 000894979 *p.p.* (top right-hand specimen), photo at CANB, MEL 59723).

Amaranthus mitchellii var. *strictifolius* Domin, *Biblioth. Bot.* 89: 78 (1921). *Type*: at the foot of Mt Walker, Queensland, Feb. 1910, *K. Domin s.n.* (holo: PR 526423, photo at CANB).

[*Amaranthus undulatus auct. non* R.Br.: J. Lindley in T.L. Mitchell, *J. Exped. Trop. Austr.* 102 (1848).]

Distribution. Commonly occurs on the Barkly Tableland, Northern Territory, south into the Lake Eyre region of northern South Australia, central Queensland and northern New South Wales. It has also been recorded from Roy Hill and Kununurra in the Pilbara and Kimberley regions of Western Australia, the latter possibly as an introduction, and once as an introduction in Sydney, New South Wales.

Typification. Several collections are cited by Bentham (1870) in the original protologue, from Queensland: Flinders River, *Sutherland s.n.* (MEL 59729); Charleville, *Giles s.n.* (MEL 59721); Armadilla, *W. Barton* 36 (MEL 59724); and New South Wales: Narren River, *T.L. Mitchell s.n.* (BM 000894979, K 000356723); between the Darling and Cooper's Creek, *Neilson s.n.* (MEL 59722); Ballandool River, *Locker s.n.* (MEL 59728). The K sheet of the Mitchell gathering has been chosen as the lectotype as it is the most complete and representative specimen, and is the only sheet annotated by Bentham with reference to *A. undulatus*. Isolectotype material at BM comprises two taxa, one plant of *Amaranthus mitchellii* at the top right and two stems of *Chenopodium* sp. on the lower part of the sheet. Bentham cites Mitchell's collection as occurring in Queensland but according to the coordinates cited by Mitchell (1848: 103), 'Lat. 29° 6' 33 ' S', the specimens were more than likely collected south of the border in New South Wales.

Notes. Several collections (e.g. *R.J. Bates* 47269 (CANB), *W.R. Barker* 285 (AD, CANB), *N.N. Donner* 9834 (AD, CANB)) from northern and north-eastern South Australia represent plants apparently

intermediate between *Amaranthus mitchellii*, *A. cuspidifolius* and *A. cochleitepalus*. These plants have inflorescences of dense sessile clusters of flowers in the leaf axils as in *A. cochleitepalus*, broadly spathulate, reflexed tepals similar to *A. cuspidifolius* and *A. mitchellii*, and narrowly ovate to ovate, obtuse to emarginate leaves as in *A. mitchellii*. Further research is required to ascertain the status of these plants and whether they warrant recognition as a distinct taxon.

18. *Amaranthus muricatus (Moq.) Hieron., *Bol. Acad. Nac. Ci.* 4: 421 (1882); *Euxolus muricatus* Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 276 (1849). *Type*: prope Mendoza, *Gillies s.n.* (*syn*: K *n.v.*); Buenos-Ayres, *Tweedie* s.n. (*syn*: *n.v*).

Distribution. Native to South America, now naturalised in Africa, Europe and Australia. In Australia it is a weed of disturbed ground in southern South Australia, New South Wales and Victoria.

19. *Amaranthus powellii S.Watson, *Proc. Amer. Acad.* 10: 347 (1875). *Type*: United States, grown at Harvard University, 1874, seed obtained from Arizona Indians by *Powell s.n.*, US 16163 (*holo*: US 16163 *n.v.*; *iso*: MO *n.v.*, *fide* J.D. Sauer, *Ann. Missouri Bot. Gard.* 54(2): 108, 1967).

[*Amaranthus hybridus auct. non* L.: W.M. Curtis, *Student's Fl. Tas.* 3: 566 (1967).]

[*Amaranthus hybridus auct. non* L. subsp. *hybridus*: W.M. Curtis, *Student's Fl. Tas.* 3: 566 (1967).]

[*Amaranthus hybridus* subsp. *incurvatus auct. non* (Timeroy ex Gren. & Godr.) Brenan: W.M. Curtis, *Student's Fl. Tas.* 3: 566 (1967).]

[*Amaranthus retroflexus auct. non* L.: W.M. Curtis, *Student's Fl. Tas.* 3: 566 (1967).]

Distribution. Native to western North and South America; since 1900 its distribution has expanded to include the eastern USA, Europe, India, southern Africa and Australia. A weed of disturbed sites in all Australian states and territories except the Northern Territory.

20. *Amaranthus quitensis Kunth, *Nov. Gen. Sp.* (quarto ed.) 2: 194 (1817). *Type*: 'Crescit in ripa fluvii Guallabambae, (Regno Quitensi)' [Ecuador], *Humboldt & Bonpland* 3082 (*holo*: P *n.v.*, *fide* M. Costea *et al.*, *Sida* 19(4): 956, 2001).

Distribution. Native to riverbanks in South America and a weed throughout most of that continent, semi-cultivated as a food dye. In Australia an uncommon weed in New South Wales from Muswellbrook to Sydney.

21. *Amaranthus retroflexus L., *Sp. Pl.* 2: 991 (1753). *Type*: 'Habitat in Pensylvania [Pennsylvania]. Kalm' – cultivated material from Uppsala Botanic Garden, Herb. C. Linnaeus 1117.22 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* C.C. Townsend in E. Nasir & S.I. Ali (eds), *Fl. W. Pakistan* 71: 13, 1974).

Distribution. Native to North America, now a widespread weed in temperate areas of the world. In Australia it is a weed of disturbed ground near Esperance, Western Australia, Alice Springs in the Northern Territory, in South Australia, Queensland, New South Wales, the Australian Capital Territory and Victoria.

22. Amaranthus rhombeus R.Br., *Prodr.* 414 (1810); *Euxolus rhombeus* (R.Br.) Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 268, 272 (1849). *Type*: tropical areas of Northern Territory and Queensland, 'North Coast', *R. Brown, Iter Australiense 3050* (*holo*: BM 000522509, photo at CANB; *iso*: K 000356722 *n.v.*, photo at CANB).

Distribution. Mostly found along the northern coast of the Northern Territory, on the Cobourg and Gove Peninsulas, Groote Eylandt and nearby islands. It also occurs in north-east Queensland in the vicinities of Chillagoe and Mungana.

23. *Amaranthus spinosus L., *Sp. Pl.* 2: 991 (1753). *Type*: 'Habitat in India', Herb. C. Linnaeus 1117.27 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* W. Fawcett & A.B. Rendle, *Fl. Jamaica* 3: 130, 1914).

Distribution. Native of tropical America. In Australia it is a weed of poor soils in higher rainfall areas such as the Gove Peninsula, Northern Territory, east coast of Queensland, northern New South Wales, and with one record from Tasmania. It is also recorded from Christmas Island (Barker 1993).

24. *Amaranthus tricolor L., *Sp. Pl.* 2: 989 (1753). *Type*: 'Habitat in India', Herb. C. Linnaeus 1117.7 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* C.C. Townsend in E. Nasir & S.I. Ali (eds), *Fl. W. Pakistan* 71: 14, 1974).

Amaranthus melancholicus L., *Sp. Pl.* 2: 989 (1753). *Type*: 'Habitat in India', Herb. C. Linnaeus 1117.4 (*lecto*: LINN *n.v.*, *fide* C.C. Townsend in J.M. Bosser *et al.* (eds), *Fl. Mascareignes* 142: 11, 1994).

Distribution. A popular ornamental and edible plant in the tropics with a widespread distribution, possibly originating in Asia. In Australia it is recorded from the Ord River area, Western Australia, on Mallapunyah and Wollogorang Stations in the Gulf of Carpentaria, Northern Territory and doubtfully naturalised in the Darling Downs region of southern Queensland (Bostock & Holland 2007). Also occurs on Christmas Island (Barker 1993).

25. Amaranthus undulatus R.Br., *Prodr.* 414 (1810); *Euxolus undulatus* (R.Br.) Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 268, 272 (1849). *Type*: Arnhem N Bay [Melville Bay, Northern Territory], *R. Brown, Iter Australiense* 3047 (*holo*: BM 000522508 *p.p.* (right hand side), photo at CANB, iso: K *n.v.*, *fide* A. Kanis *in adnot.* and D. Foreman, ABLO, *pers. comm.* (1997).

Amaranthus pallidiflorus F.Muell., *Fragm.* 1(5): 140 (1859), as *Amarantus*. *Type*: on the dry banks of watercourses between the Victoria and Fitzmaurice Rivers, Arnhem Land, Oct. 1855, *F. Mueller s.n.* (*holo*: MEL 39733).

Amaranthus leptostachyus Benth., *Fl. Austral.* 5: 214 (1870), as *Amarantus*. *Type*: 'Two Isles' off Cape Flattery, [Queensland], 31 July 1848, *J. MacGillivray s.n.*; (*lecto*: K, here designated, photo at CANB; *isolecto*: K, photo at CANB).

[*Amaranthus grandiflorus auct. non* (J.M.Black) J.M.Black, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 136 (2000).

Distribution. Occurs throughout the Pilbara and Kimberley regions (including offshore islands) of Western Australia, around Victoria River and the Gulf of Carpentaria in the Northern Territory, near Mt Isa and Mt Mulligan in Queensland and on offshore islands and cays in the Torres Strait and off the east coast of Queensland. Recorded (as *A. leptostachyus*) from New Guinea (Backer 1949) but this may be an introduction (Kanis 1978).

Typification. Of the available original material of *Amaranthus leptostachyus*: Port Darwin, North Australia [Northern Territory], Oct. 1849, *Schultz s.n.* (K, photos at CANB, MEL 59759; ?AD 98147273); 'Two Isles' off Cape Flattery, [Queensland], 31 July 1848, *J. MacGillivray s.n.*; (K, photo at CANB), the MacGillivray collection has been chosen as the lectotype, as it is the most complete and representative specimen.

26. *Amaranthus viridis L., *Sp. Pl.* 2nd edn, 2: 1405 (1763); *Amaranthus gracilis* Desf., *Tabl. École Bot.* 43 (1804); *Euxolus viridis* (L.) Moq. in A.L.P.P. de Candolle, *Prodr.* 13(2): 273 (1849). *Type*: 'Habitat in Europa, Brasilia', Herb. C. Linnaeus 1117.15 (*lecto*: LINN *n.v.* [IDC microfiche seen], *fide* W. Fawcett & A.B. Rendle, *Fl. Jamaica* 3: 131, 1914).

Distribution. Probably native to Europe but now a cosmopolitan weed. In Australia it is naturalised in all mainland states and territories, including some of the Barrier Reef and Torres Strait Islands off the Queensland coast. It is also recorded from Christmas Island and the Coral Sea Islands (Barker 1993).

Excluded names

Amaranthus enervis (F. Muell.) Benth., *Fl. Austral.* 5: 216 (1870), as *Amarantus*

= *Scleroblitum atriplicinum* (F. Muell.) Ulbr. (Chenopodiaceae), *fide* P.G. Wilson, *Fl. Australia* 4: 175 (1984)

Amaranthus tenuis Benth., *Fl. Austral.* 5: 216 (1870), as *Amarantus*

= *Scleroblitum atriplicinum* (F. Muell.) Ulbr. (Chenopodiaceae), *fide* P.G. Wilson, *Fl. Australia* 4: 175 (1984)

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Plant Industry) for taking the photographs. I am very grateful to my colleagues Brendan Lepschi, Anna Monro and Kirsten Cowley (CANB) for the time they generously spent in providing comments and suggestions on the manuscript, and Terena Lally and Cathy Miller for reviewing the manuscript. Finally many thanks to Chris Marshall who continues to give me encouragement for my work.

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Index to taxa

Names in bold ***italics*** are accepted in this treatment. Names in italics are considered to be synonyms or are marked as 'Excl.' for excluded names. Taxon numbers are those used in the text.

A reduced circumscription of *Balaustion* and description of the new genus *Cheyniana* (Myrtaceae: Chamelaucieae)

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Abstract

B.L. Rye. A reduced circumscription of *Balaustion* and description of the new genus *Cheyniana* (Myrtaceae: Chamelaucieae). *Nuytsia* 19(1): 129–148 (2009). The myrtaceous genus *Balaustion* Hook. is reduced to its original monotypic circumscription. *Balaustion s. str.* is closely related to *Tilophloia* Trudgen & Rye ms, both genera having stamens in a single circular series, broad filaments, a very large placenta and seeds with a large concave hilum, but *Balaustion* is distinguished by its prostrate habit with adventitious roots, basifixed anthers and long tubular flowers adapted to pollination by birds. A second bird-pollinated species with elongated flowers, previously known as *B. microphyllum* C.A.Gardner, is transferred into the new genus *Cheyniana* Rye as *C. microphylla* (C.A.Gardner) Rye. Since the type material of this species is missing, it is lectotypified on the original illustration. Another large-flowered species, but with more spreading, apparently insect-pollinated flowers, is described as *C. rhodella* Rye & Trudgen. *Cheyniana* is related to also *Oxymyrrhine* Schauer, which it resembles in its very reduced anthers and narrow filaments, but differs in its large colourful petals and woody indehiscent fruit. Both of the small genera treated in this taxonomic revision belong to the tribe Chamelaucieae and are restricted to the south-west of Western Australia.

Introduction

The tribe Chamelaucieae *s. lat.* of the Myrtaceae consists mainly of small-flowered insect-pollinated species and, especially among the many taxa that have traditionally been included within sections of *Baeckea* L., most species have white or pink flowers with a broad open disc surrounded by widely spreading petals. Against this backdrop, the small genus *Balaustion* Hook has been readily distinguished by the large size, tubular shape and orange to red colouring of its bird-pollinated flowers (see images in Corrick *et al.* (1996: 112), Keighery (2004) and Western Australian Herbarium 1998–). These striking floral adaptations have hindered attempts to determine the true affinities of the two species currently placed in *Balaustion*. Convergent similarities are commonly found among taxa with flowers adapted to pollination by birds and can easily mask their morphological similarities to insect-pollinated relatives, for example as recorded in the Fabaceae (Crisp 1996).

While some of the many morphological differences between the two bird-pollinated species of *Balaustion s. lat.* have been used to separate them from one another in publications such as Blackall and Grieve's (1980) key to south-western Australian Myrtaceae, no serious examination of these

differences has been made. However, differences in several molecular sequences of the two species led Wilson *et al.* (2004) to conclude that *Balaustion* was not monophyletic.

In the revision of *Balaustion* presented here, the genus is restored to its original monotypic state. A second bird-pollinated species that was added to the genus by Gardner (1927) appears to be much more closely related to an unnamed insect-pollinated species than to *Balaustion s. str.*, having significant differences from the latter in its stamens, fruits and seeds. The new genus *Cheyniana* Rye is described here to accommodate Gardner's bird-pollinated species and its insect-pollinated relative.

Taxonomic history

Morphological evidence

Balaustion pulcherrimum Hook was one of many Western Australian species of the Chamelaucieae that were first collected by James Drummond. In a letter regarding specimens collected in about 1848, Drummond (1850: 31) noted 'I found several remarkable Myrtaceae plants; one appears to be a new genus, with flowers (though smaller) as handsome as those of a pomagranate which they resemble in shape and colour.' This very attractive species was described as a new genus three times, first as *Balaustion* by Hooker (1851), shortly afterwards as *Punicella* by Turczaninow (1852) and finally as *Cheynia* by Harvey (1855), all based on Drummond's material. While Drummond (1850) had been the first to publish a description of the genus and its type species, which he intended to call *Cheynia pulchella*, this name was not validly published until, at Drummond's request, Harvey published it in one of Hooker's journals. This was four years after Hooker himself had established the genus as *Balaustion*. Hooker had chosen a very similar epithet, *pulcherrimum*, for the species, suggesting that he also based it on Drummond's earlier manuscript name. Hooker (1851) believed the nearest affinity of the genus to be with *Hypocalymma* (Endl.) Endl., but considered the new genus to be 'superior' in the beauty of its flowers, which were of the 'most brilliant scarlet'.

Both Bentham (1867) and Niedenzu (1893) maintained *Balaustion* as a monotypic genus, although they treated a number of other genera as sections of *Baeckea s. lat.* Bentham distinguished *Balaustion* from other genera with opposite leaves by its large, red, urceolate flowers with numerous free stamens. He did not comment on the relationships of the genus but apparently agreed with Hooker as he placed it next to *Hypocalymma* in his treatment. However, he later noted (Bentham 1868: 135) that Mueller believed that *Balaustion* should be united with *Baeckea s. lat.* but justified maintaining the genus since 'the large coloured calyx gives to the single species so peculiar an aspect, that we are unwilling to suppress the genus, so long, at any rate, as the fruit and ripe seeds shall remain unknown'.

Niedenzu (1893) placed *Balaustion* adjacent to *Baeckea* rather than *Hypocalymma*. He recognised the taxonomic importance of a derived anther type, which he used to define his new group *Baeckea* subgenus *Hysterobaeckea* Nied., but kept *Balaustion* as a distinct genus, perhaps because its anthers were so modified that he did not realise that they were of the basic type that defines the *Hysterobaeckea* group.

Up to this point, only one bird-pollinated species had been described in the whole of the *Baeckea* group. When a second bird-pollinated species was discovered in the 1920s, Gardner (1927: 67) had no doubt that it belonged to the same genus, stating that the new taxon *Balaustion microphyllum* 'would appear to be developed from *B. pulcherrimum* in a northern area isolated from the range of that

species'. Although this new species actually bore only a superficial resemblance to *B. pulcherrimum*, for example showing marked differences in its anther type, filament shape, fruit dehiscence and seed morphology, it was maintained in the same genus in all subsequent publications.

Unaware of the morphological discrepancies between the two bird-pollinated species, Trudgen (1987, 2001: 546) included *Balaustion s. lat.* in his reniform-seeded lineage, placing it with genera such as *Euryomyrtus* Schauer, *Rinzia* Schauer and *Hypocalymma*. Keighery (2004: 273) considered that *Balaustion* was 'closely related to, and perhaps not distinct from, members of *Hypocalymma*, such as *H. puniceum*, the main difference being all members of *Hypocalymma* are insect pollinated'[1].

Since 2002, when a project funded by the *Australian Biological Resources Study* on the taxonomy of members of the *Baeckea* group of genera commenced, evidence has been accumulating that throws doubt on all of the relationships suggested in the taxonomic literature outlined above for *Balaustion s. lat.* Morphological data obtained in the current study indicate that both of the bird-pollinated species should be included in the *Hysterobaeckea* lineage but that they are not closely related to one another within this group

Evidence from palynology and molecular sequences

The taxonomic decisions made in all of the publications outlined above have been based entirely on gross morphology. Two other lines of enquiry, palynology and molecular sequencing, have both suggested significant differences between the two bird-pollinated species of *Balaustion s. lat.*

Pollen studies of Myrtaceae have included both *Balaustion pulcherrimum* (Pike 1956: fig. 78) and *B. microphyllum* (Patel *et al.* 1984: fig. 44C). In the former study (pp. 44, 49), *Balaustion* was considered to be distinguished from other genera of Chamelaucieae sampled in having 'prolate-spheroidal' pollen grains. Its grains were 19–23 µm across. In the latter study (p. 939), pollen grains of *B. microphyllum* were measured as *c.* 17 µm across and were described as being 'brevicolpate with a psilate surface and a circular, thin-walled area on the pole'; these did not match the apparently unique pollen type found in *B. pulcherrimum*.

Molecular data from a study of the *mat*K chloroplast gene and the *atp*B-*rbc*L intergeneric spacer (Lam *et al.* 2002) gave the first indication that *Balaustion pulcherrimum* was related to a new genus, *Tilophloia* Trudgen & Rye ms (Trudgen & Rye in prep.) represented by *Baeckea grandibracteata* E.Pritz., and an unnamed species [as *B. grandis* E.Pritz.]. A bootstrap support of 74% was recorded for those three species and Lam *et al.* noted (p. 542) that the 'three species possess the uniquely derived indel *r* and the two *Baeckea* species also possess indel *p*'.

Increased support was obtained in a later study (Wilson *et al.* 2004) using two additional chloroplast regions, the 5' *trn*K intron and part of the *ndh*F gene, this time achieving a Jackknife value of 86% and a decay index of 3. *Balaustion microphyllum*, which had not been sampled in the earlier study, grouped with a species that Bentham (1867) included in *Baeckea* section *Oxymyrrhine* (Schauer) Benth. & Hook.f. with over 90% bootstrap support and a decay index of 11. *Oxymyrrhine* Schauer is reinstated as a distinct genus in the accompanying paper (Rye 2009).

[1] *Hypocalymma puniceum* C.A.Gardner is one of the largest-flowered members of the genus, having bright pink flowers up to 25 mm in diameter.

Methods

Similar methods for obtaining measurements were used here to those of other recent papers on Western Australian Chamelaucieae such as Rye (2002), and the holotype of the new species *Cheyniana rhodella* has been lodged at PERTH. Precise localities are withheld for the specimens cited of that species as it has conservation priority. The distribution maps were compiled using DIVA-GIS freeware Version 5.2.0.2. The phytogeographic regions and Interim Biogeographic Regionalisation of Australia (IBRA) districts used here are those used in FloraBase (Western Australian Herbarium 1998–), where continually updated distribution maps are available.

Morphology

This section compares the morphology of *Balaustion* and *Cheyniana* and also notes some of the characters that separate *Hypocalymma* from both genera.

Habit. Both genera are low shrubs. *Balaustion* has a maximum height of 0.2 m and produces long prostrate stems radiating from the centre of the plant, with a series of erect leafy branchlets arising along each prostrate stem (Figure 1A). The longer stems are commonly anchored about half way along their length by a single thick adventitious root below one of the erect branchlets. Occasionally, several adventitious roots are present on the same prostrate stem, with each root solitary at a node, as shown in Figure 1A. *Cheyniana* does not produce adventitious roots and has a more shrubby habit, with the bird-pollinated species up to 0.4 or possibly 0.5 m high and the insect-pollinated species up to 0.8 m high.

There appears to be a difference between the two genera in their fire-tolerance (Alex George pers. comm.), with *Cheyniana* probably being killed by fires whereas *Balaustion* regenerates from the base after fires. The regeneration is by multiple stems or shoots, although it is not clear whether this is from a lignotuber or just from a thickened main stem.

Leaves. The leaves of both genera have a short, but well-defined, petiole, with the blade up to 3 mm long in *Cheyniana* and up to 6 mm long in *Balaustion*. Oil glands are large in *Cheyniana* and may be very prominent (Figure 2A & F), whereas *Balaustion* has small oil glands that are not obviously protruding from the surface of the blade (Figure 1B–D). *Balaustion* also differs from *Cheyniana* in having a white apical point up to 0.3 mm long.

On young leaves of *Balaustion* the petiole is flanked by filiform erect stipules, which often persist on older leaves (visible on one side of each of the leaves in Figure 1B). There are usually additional filiform structures hidden behind the petiole in each axil. Stipules are absent or inconspicuous in *Cheyniana*.

Inflorescence. Both genera have solitary, axillary flowers. Few flowers are produced on each branchlet, usually only one pair, but occasionally two or three pairs, in which case the pairs may be in adjacent axils or they may be separated by at least one sterile pair of axils. Each flower has a peduncle terminated by two opposite bracteoles, which often persist in fruit. In *Cheyniana* there is often a short pedicel separating the bracteoles from the base of the flower, but in *Balaustion* the flowers are usually sessile within the subtending bracteoles.

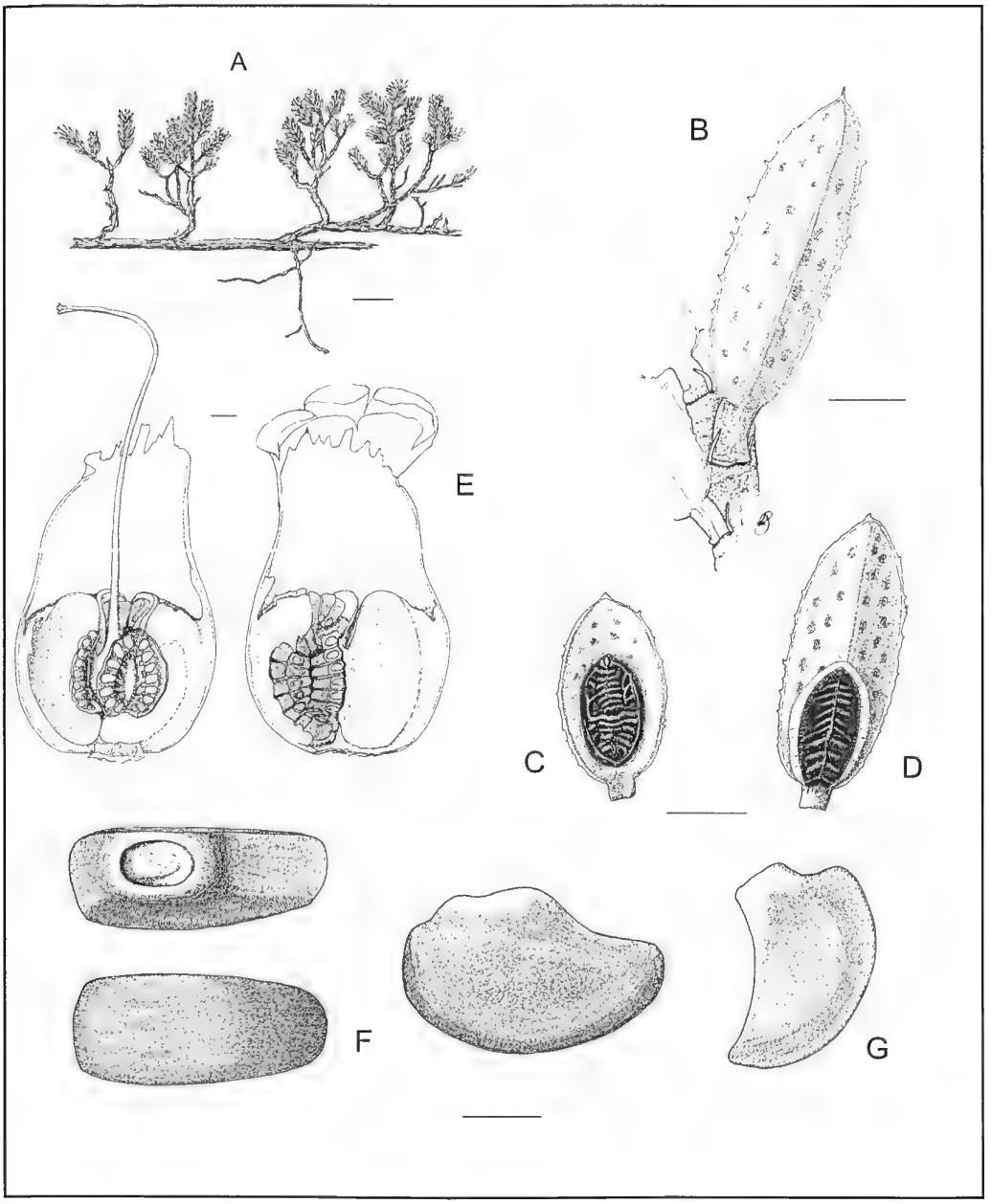

Figure 1. *Balaustion pulcherrimum*. A – prostrate stem with adventitious roots; B – leaf (outer surface) and stipules; C – inner leaf surface, with a black scale formed by a whitefly; D – outer leaf surface with a whitefly scale; E – fruit cut open to show a large placenta (front view, i.e. abaxial surface) and all the seeds that were attached to it in the other half of the split fruit; F – seed (3 views); G – chaff piece. Drawn by Lorraine Cobb from *B.L. Rye* 241155 *& M.E. Trudgen* (A, B), *F. & N. Mollemans* 2798 (C), *J. Coleby-Williams* 232 (D–G). Scale bars are 10 mm (A) or 1 mm (B–F).

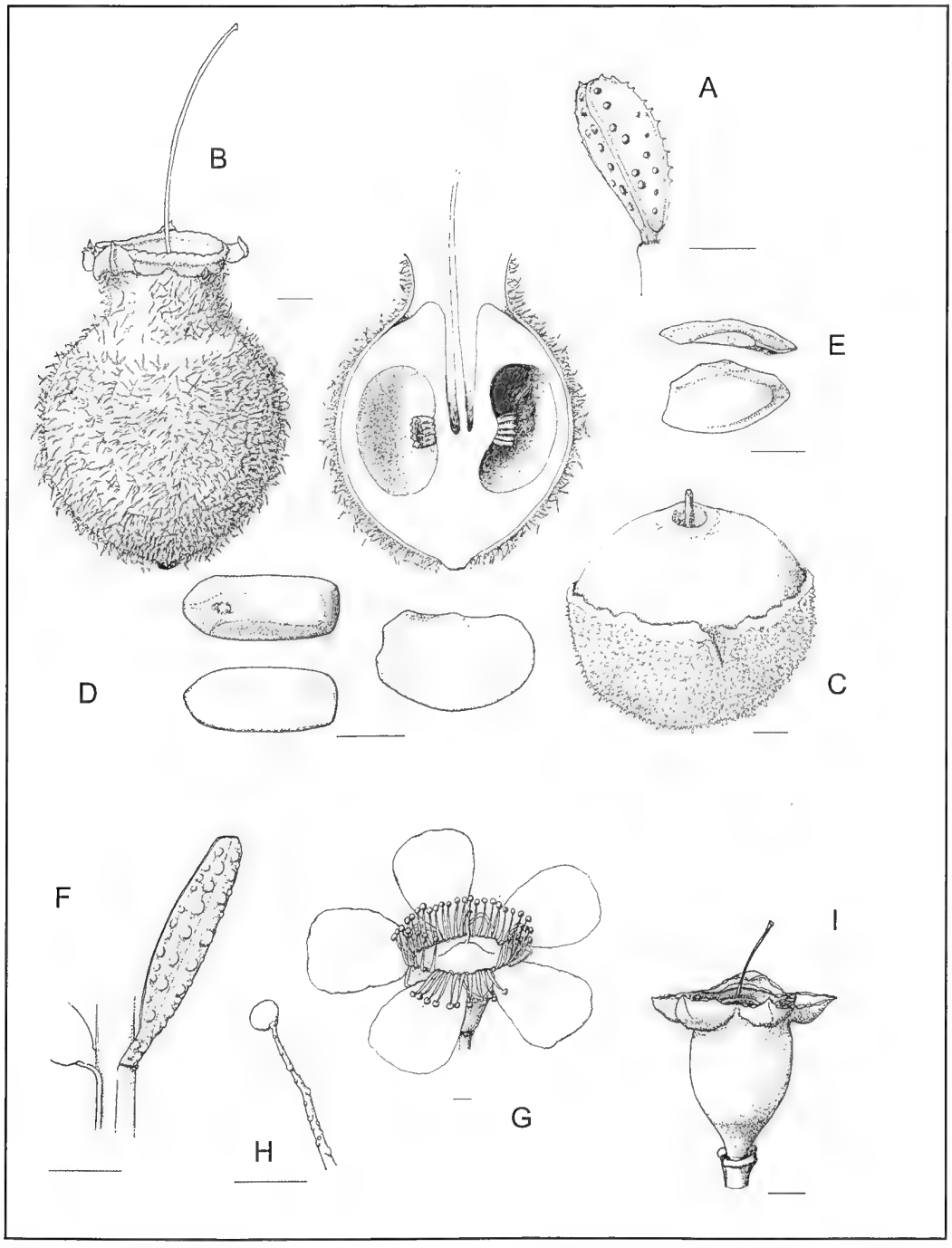

Figure 2. A–E. *Cheyniana microphylla*. A – leaf, B – fruit from outside and cut open, C – indehiscent fruit with other parts of flower removed, D – seed (3 views), E – chaff piece (2 views); F–I. *Cheyniana rhodella*. F – leaf, G – flower, H – stamen showing tubercles on filament, I – immature fruit. Drawn by Lorraine Cobb from *G. Perry* 366 (A,B), *C.A. Gardner* 12032 (C–E), *A. Carr* 114 (F–H) and M.E. Trudgen 5387 (I). All scale bars are 1 mm.

Flowers. Flowers are large and colourful in both genera. In *Balaustion* they have a diameter of about 15–25 mm and a smooth tubular hypanthium up to 20 mm long, while the other bird-pollinated species, *Cheyniana microphylla*, has flowers 10–14 mm in diameter and a hairy hypanthium up to 8 mm long. In *Balaustion*, the hypanthium and calyx have a similar texture and colour to the petals, whereas in *Cheyniana microphylla*, the hypanthium and calyx tend to be more greenish or yellowish than the petals. In both cases the petals may vary from yellowish or bright orange to deep red, with the colour deepening as the flowers mature. The insect-pollinated species *C. rhodella* differs from the other two species in having bright pink petals and a hypanthium only *c.* 2.5 mm long, although its flowers are up to 16 mm in diameter. It lacks hairs but has prominent oil glands towards the top of the hypanthium and on the sepals.

The sepals are herbaceous and tend to be prominently keeled or horned in *Cheyniana*, especially in *C. microphylla*, but are more uniformly thin and petal-like in *Balaustion*. The petals are 4.5–7 mm long in *Cheyniana* and 7–9 mm long in *Balaustion*.

Some genera in the Chamelaucieae have small outgrowths (processes) inserted between the petals and stamens. These are usually inconspicuous but are particularly well developed in most species of *Euryomyrtus* Schauer (see Trudgen 2001: fig. 2C, F & I). Antipetalous processes are minute or absent in *Cheyniana* and absent in *Balaustion*.

Androecium. The stamens are free and indefinite in both genera, and staminodes are rare or absent. In *Balaustion*, as in most members of the tribe Chamelaucieae, those stamens opposite or closest to the centre of a petal are the longest and those opposite the centre of a sepal the shortest. This is also the case in *Cheyniana* but in *C. microphylla* the stamens are also in two series with the outer stamens longer than the inner ones. *Hypocalymma* differs from both genera in having its stamens united at the base.

Balaustion has 15 to 35 stamens arranged with their bases contiguous or with occasional small gaps between them. The filaments are compressed, a characteristic that is usually most obvious near their base where they have a broad attachment to the staminophore. The stamens form a single continuous circle or, when most numerous, may have a few forming an inner circle.

More numerous stamens, 30 to 60 per flower, occur in *Cheyniana*. Except at the extreme base, the filaments are more or less terete and filiform, and the longer ones have a scattering of prominent glands, as illustrated in Gardner (1927: pl. 25L) and Figure 2H. They may be contiguous at the staminophore or have small gaps between them, with the gaps perhaps appearing more significant than in *Balaustion* because of the narrower filaments.

Anthers. The stamens of *Cheyniana* have a very slender attachment of the filament to the small, more or less globular anther (Figure 2H). The thecae are closely fused to one another and the connective gland to form this globular structure, which is dehiscent by two basally divergent short slits or elliptic pores. The stamens appear to be dorsifixed as the filament is attached at the centre of the anther, which faces in towards the centre of the flower. This kind of attachment should perhaps be regarded as secondarily dorsifixed as it is not considered to be equivalent to the primitive dorsifixed anther of the Myrtaceae as a whole, one which has the filament attached dorsally near the centre of the connective below a free connective gland.

In *Balaustion* the stamens have a very long filament and an erect basifixed anther. The anthers are much longer than in *Cheyniana* and are longitudinally dehiscent by parallel slits. Their connective

gland is incorporated within a very broad connective and bulges dorsally in young anthers but does not form a free structure.

In *Hypocalymma* the anthers look more similar to those of *Balaustion* than those of *Cheyniana* as they are basifixed and dehisce by long slits. They vary from having an obvious free connective gland on the dorsal surface to having the gland visible as a lobe on the ventral surface of the anther, located at the centre between two curved thecae as in *H. robustum* (Endl.) Lindl. (see Rye 1987: fig. 155D). Although always quite different in structure from the anthers of *Balaustion*, they can sometimes appear quite similar in overall shape. The superficial similarity of the anthers of *Balaustion* and *Hypcalymma* is one of the factors that led to the two genera being considered closely related.

Gynoecium. The ovary is fully inferior with a flat disc in *Balaustion* but has a raised centre of the disc (see Figure 2G) in *Cheyniana*. Both genera have a slender style with its base enclosed in a cylindrical depression in the disc at the centre of the ovary, a small stigma and numerous ovules arranged right around the margin of each placenta. However there is a marked difference in the shape of the placentas in the two genera, those of *Balaustion* being very large and dorsiventrally compressed whereas those of *Cheyniana* are smaller and shortly cylindrical to conic. The placentas retain these distinct shapes in fruit, as shown in Figures 1E and 2B; the latter figure also shows the deep depression enclosing the base of the style.

Fruit. The fruit is large, multi-locular and more or less globular in both genera. In *Balaustion* it is moderately thick-walled, dehiscent by three valves and largely inferior (Figure 1E). In *Cheyniana* the fruit is very hard, very thick-walled, indehiscent and half to three-quarters inferior (Figure 2B & C). The lack of valves on the summit of the fruit is evident in Figure 2C.

Seeds. Seeds are shiny and somewhat facetted in both genera, with the hilum much larger and more concave in *Balaustion* (Figure 1F) than in *Cheyniana* (Figure 2D). In *Balaustion* the seeds are slightly to distinctly colliculate and 2.4–2.6 mm long. The chaff pieces usually vary greatly in size, but are paler and more obviously facetted than the seeds (Figure 1G). *Cheyniana* has smaller, smoother seeds. Those of *C. microphylla* are 1.4–1.7 mm long, but mature seeds have yet to be observed in the insect-pollinated species *C. rhodella*. Chaff pieces in *C. microphylla* are darker than the seeds, and are not very crustaceous, tending to be either very compressed or broader and irregularly shrunken (Figure 2E).

The seeds of *Hypocalymma* differ from those of *Balaustion* and *Cheyniana* in being more curved and in having a modified, usually distinctively coloured, region on the inner surface (see Rye & Trudgen 2008: fig. 3C).

Adaptive biology

Many of the distinctive characteristics of *Balaustion* and *Cheyniana* are the result of their coevolution with pollinators, but coevolution has also occurred with harmful organisms such as sap-sucking or seed-eating insects. Other characters relate to adaptations for seed dispersal, competition with other plant species and many other factors, most of which have not been studied. This section examines a few of these adaptations in the two genera and in some of the genera that have been hypothesised to be their closest relatives.

Pollination

Balaustion pulcherrimum and *Cheyniana microphylla* have many morphological specialisations related to bird-pollination, including their habit. Flowers are borne close to the ground, either concentrated around the edges of a ground-hugging shrub (*Cheyniana*) or along long prostrate stems (*Balaustion*), so that birds standing on the ground can easily reach them. Presumably, many kinds of honeyeaters would be responsible for pollination of these two plant species, but apparently the only published record has been of the White-fronted Honeyeater, *Phylidonyris albifrons*, visiting the flowers of *Cheyniana microphylla* [as *Balaustion*] in East Yuna Reserve (Dell & McGauran 1981). Keighery (1982, 2004) recorded both species of *Balaustion s. lat.* as bird-pollinated taxa but gave no details of his observations of the birds involved.

Both of the bird-pollinated species have a cylindrical hypanthium containing copious nectar. In *Balaustion*, the flower buds are distinctly tubular from an early stage, with the hypanthium short but uniformly broad, and undergo a rapid elongation before they open. In *Cheyniana microphylla*, the buds are more obconic at first, but become more tubular at maturity, showing very rapid elongation just before they open and having numerous tubercles that also elongate very rapidly to become long hairs by the time the flowers reach anthesis. The rapid late elongation of the hypanthium may reflect the relatively recent evolution in both groups of bird-pollinated flowers from previously short, insect-pollinated flowers. In *Cheyniana rhodella*, the hypanthium is more tubular than normal for an insect-pollinated flower, so possibly is pre-adapted to a change to bird-pollination.

Evolution of bird-pollination might be expected to occur in relatively large-flowered species that already present limited opportunities for bird visitation. *Hypocalymma* is one such genus that would seem pre-adapted, with its large, often colourful flowers densely arranged on moderately strong stems. There is one record of visitation by the Brown Honeyeater, *Lichmera indistincta*, on *H. xanthopetalum* F.Muell. and there are records of the Honey Possum, *Tarsipes rostratus*, feeding on two species of *Hypocalymma* (see Brown *et al.* 1997, Turner 1982), so the genus does not appear to be exclusively insect-pollinated. However, previous suggestions (see taxonomic history section) of a relationship between this genus and *Balaustion* are not supported by the morphological and molecular evidence. As noted earlier, *Hypocalymma* has basally connate stamens, a free connective gland on its anthers and more curved seeds with a proliferation on their inner surface.

A quite different species group appears to have been the progenitor of *Balaustion* and its close relative *Tilophloia* ms The close relationship between *Balaustion* and *Tilophloia* that was indicated by the molecular evidence (see taxonomic history section) is supported by morphological similarities, with both genera having a low spreading habit, sepals without ridges or horns, stamens arranged in a single continuous circle, filaments broad and markedly flattened at the base, and very large placentas bearing seeds with a large concave hilum. Although most species of *Tilophloia* have white flowers, there is one undescribed species, currently known as *Baeckea* sp. Diemals (A.P. Brown 3636), that has large flowers with bright orange petals *c.* 10 mm long and a style *c.* 12 mm long. Because of its unusual flower size and colour, this species was originally thought to be a *Balaustion*.

The origin of bird-pollination in *Cheyniana* has evidently occurred within the genus as it also includes an insect-pollinated species with large colourful flowers. The closest relative of this genus, based on the molecular evidence, is *Oxymyrrhine*, which is fairly similar in its anther morphology, more or less terete filaments and small hilum, but differs in having small insect-pollinated flowers with white or pale pink petals and a dehiscent fruit.

Phytophagous insects

Black scales formed by the larvae of whiteflies (family Aleyrodidae of the Hemiptera) occur on *Balaustion* and on the related genus *Tilophloia*. In *Balaustion* the scales of young larval stages (several instars) are very dorso-ventrally compressed whereas the final instar has a thicker profile (Woodward *et al.* 1970). At least one kind of whitefly scale has a convex dorsal surface and can be found anywhere on the inner or outer surface of the leaf (Figure 1C). Another kind of whitefly produces a strongly ridged dorsal surface on the scale of its final instar, which always occurs at the base of the outer surface of the leaf lamina, with its anterior end adjacent to the petiole (Figure 1D). Both kinds of scales tend to have a compressed white border of secreted waxy material. So far, no black scales have been observed on the leaves of *Cheyniana*, although white furry structures are present and these have not been observed on *Balaustion*.

Whether this difference in insect associations backs up the morphological and molecular evidence separating the two genera, or whether it results more from the difference in geographic distribution of the two genera, is not known. Similar kinds of black scales of whitefly larvae have been observed on many other genera of the Chamelaucieae, including some members of the genus *Oxymyrrhine* (Rye 2009), so do not appear to be highly specific in their host plants. Still, the apparent absence of whiteflies on *Cheyniana* may be significant in view of the moderately high frequency of their occurrence on *Balaustion*.

Seed biology

The multi-locular, indehiscent fruit of *Cheyniana* is very thick-walled and difficult to dissect, as it is very woody. One of the likely effects of this kind of fruit is a marked delay in seed germination, as has been recorded for indehiscent fruits in other Myrtaceous genera (Rye & James 1992). This delay could be particularly pronounced in such a woody fruit, but presumably the thick walls would give the seeds extra protection from predation, desiccation and other environmental hazards during the long period before germination.

Indehiscent fruits in the Myrtaceae usually have a reduced number of seeds and the testa of the seeds is usually thin and membranous. Seed number is reduced in *Cheyniana*, with few of the ovules developing into seeds, and the testa is very thin and easily broken although it is still crustaceous. In contrast, the capsules of *Balaustion* contain seeds with a thick crustaceous testa and it is common for the majority of ovules in each loculus to develop into seeds.

Distribution and phenology

The two very small genera treated here are south-western Australian endemics. The monotypic *Balaustion* has a distribution centred in the northern to central wheatbelt, occurring in the South West Botanical Province, South-west Interzone and extending into the adjacent Eremaean Botanical Province in the Yalgoo and Murchison IBRA districts. *Cheyniana* has two species and occurs further north in the northern sandplains of the South West Botanical Province and adjacent Yalgoo district of the Eremaean Botanical Province (Figure 3).

Both genera are predominantly spring-flowering, with the main flowering time of *Balaustion* corresponding exactly with the three spring months of September to November. The flowering season

of the more northern genus *Cheyniana* tends to start and finish earlier, with the better known of its species, *C. microphylla*, flowering from August through to October.

Descriptions and keys

The two bird-pollinated species key out successfully in Blackall and Grieve (1980) to *Balaustion s. lat.* on page 5 and to their respective species on page 88. The new insect-pollinated species keys out on page 5 to a choice between *Balaustion s. lat.* and *Hypocalymma*, where it is somewhat intermediate between the two options. The new genus *Cheyniana* could be readily keyed out prior to this couplet by the addition of a new couplet using its globular anthers, glandular-tuberculate filaments, and indehiscent fruit to distinguish it from both *Balaustion s. str.* and *Hypocalymma*. A suggested new couplet and a modified version of the existing couplet E are given below.

D1. Longest stamens with a glandular-tuberculate filament. Anthers dorsifixed, globular, dehiscent by short divergent slits or pores. Fruit very woody, indehiscent..... **Cheyniana**

D1. Longest stamens with a smooth filament. Anthers basifixed, not globular (longer and broader than thick), dehiscent by long parallel or curved slits. Fruit moderately woody, dehiscent by 2–4 valves.

E. Flowers tubular, orange to red (including tube and calyx). Ovules 16–21 per loculus ..... **Balaustion**

E. Flowers much broader than deep, with white or coloured petals and a green calyx. Ovules 1–3 per loculus in most species but up to 12 per loculus ..... **Hypocalymma**

Balaustion Hook., *Icon. Pl.* 9, t. 852 (1851). *Type*: *Balaustion pulcherrimum* Hook.

Punicella Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. St-Pétersbourg* 10: 333 (1852). *Type*: *Punicella carinata* [= *Balaustion pulcherrimum* Hook.].

Cheynia J. Drumm. ex Harv., *J. Bot. Kew Gard. Misc.* 7: 56 (1855). *Type*: *Cheynia pulchella* J. Drumm. ex Harv. [= *Balaustion pulcherrimum* Hook.].

Prostrate *shrubs*, with long stems often anchored near the middle, usually by a single adventitious root, glabrous, with leaves crowded on short lateral branchlets and fairly widely spaced on rapidly growing shoots. *Stipules* filiform, pale, shorter than to slightly exceeding the petiole. *Leaves* usually opposite and decussate, small, with a very short but well defined petiole; blade fairly flat, herbaceous, laciniate, dotted with small oil glands, abaxial surface keeled, apical point small. *Inflorescence* of solitary axillary flowers, with 1 or several decussate pairs of flowers per branchlet. *Peduncles* moderately long. *Bracteoles* opposite, persistent, broad, convex-concave and often appressed to base of hypanthium. *Pedicels* absent or very short. *Buds* very obtuse. *Flowers* large, with the hypanthium and sepals similarly coloured to the petals. *Hypanthium* up to 20 mm long, urceolate or more cylindric, smooth; adnate portion broadly obconic (becoming cup-shaped in fruit); free portion erect, longer than the adnate part. *Sepals* 5, erect, persistent in fruit, moderately large, petaline, entire. *Petals* 5, erect or somewhat spreading, shed before fruit matures, very shortly clawed, very broadly obovate to more or less circular, orange to deep red. *Antipetalous processes* absent. *Stamens* indefinite, in a circular series, erect, exceeding sepals, those directly opposite the petals longest and those directly opposite the sepals shortest; staminodes rare or absent. *Filaments* free, contiguous or nearly so, slender, expanded and compressed near the base, tapering above to a narrow distal apex, smooth. *Anthers* basifixed, introrse, long; connective broad and swollen with the gland, which is not distinct from the remainder of the

connective; thecae introrse, erect, parallel, longitudinally dehiscent. *Ovary* inferior, 3-locular; placentas broadly ovate, very large, ± sessile; ovules 16–21 per loculus. *Style* slender, terete, base inserted in a central depression on disc; stigma capitate or somewhat peltate. *Fruit* dry, largely inferior, 3-valvate, globular. *Seeds c.* 2.5 mm long, somewhat facetted, with a large curved outer surface, two large lateral surfaces, shiny, brown, slightly or distinctly colliculate, with a deeply concave inner cavity.

Notes. The distinguishing characteristics and distribution of this monotypic genus are described in previous sections of this paper.

1. Balaustion pulcherrimum Hook., *Icon. Pl.* 9: t. 852 (1851). *Type citation*: south-western Australia, between the Swan River and King George's Sound. *Type*: Mullean region, south-west of Western Australia, 1847–1849, *J. Drummond* coll. 5 suppl., no. 26 (*holo*: K 000355362; *iso*: BM 000793705, K 000355360 & 000355361, KW *n.v.*, photo PERTH 07536976).

Punicella carinata Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. St-Petersbourg* 10: 333 (1852). *Type*: Mullean region, south-west of Western Australia, 1847–1849, *J. Drummond* coll. 5 suppl., no. 26 (*holo*: KW *n.v.*, photo PERTH 07536976; *iso*: BM 000793705, K 000355360–000355362).

Cheynia pulchella J. Drumm. ex Harv., *J. Bot. Kew Gard. Misc.* 7: 56 (1855). *Type citation*: northern districts, south-west of Western Australia. *Type*: south-west of Western Australia 1847–1854 [possibly the same collection as for the earlier two but more likely a new collection from a more northern locality collected after 1849], *J. Drummond* (*holo:* TCD *n.v.*).

Illustrations. Blackall & Grieve (1980: 88), Hooker (1851: plate 852).

Shrub usually 0.2–1.2 m across, up to 0.2 m high at the centre but always with prostrate flowering stems. *Petioles* 0.4–0.6 mm long, concave on adaxial surface. *Leaf blades* ovate to narrowly obovate, 2.7–6 mm long, 1.2–1.5 mm wide, acute, green and often glossy, sometimes with margins and keel distinctly whitish, margins laciniate or sometimes entire, with a white apical point 0.15–0.3 mm long; abaxial surface with keel incurved/rounded to the apex, the larger oil glands in 2–4 main rows on each side of midvein, the keel often somewhat wing-like; adaxial surface shallowly concave/infolded, often with a central longitudinal slight groove, with oil glands fewer and usually not as large as those on abaxial surface. *Inflorescence* with 1–3 pairs of flowers per branchlet. *Peduncles* 2–4 mm long, red. *Bracteoles* 2–3.5 mm long, 3–4 mm wide, reddish, somewhat keeled, often gland-dotted. *Pedicels* usually absent but up to *c.* 1 mm long. *Flowers* mostly 15–25 mm diam., orange to deep red. *Hypanthium* 9–20 mm long, narrowing to a minimum width of 4–6 mm diam., expanding at summit to 6–8 mm diam.; adnate part somewhat rugose or gland-dotted, 5–7 mm diam.; free part (6)10–16 mm long. *Sepals* very broadly ovate or depressed-ovate, 2.5–4 mm long, 3–4 mm wide, broadly obtuse, scarious but with oil glands often obvious in central part, entire to minutely laciniate. *Petals* fairly erect to widely spreading, 7–9 mm long. *Stamens* 15–35. *Longest filaments* 6.5–8(11) mm long, 0.4–0.5 mm wide above the base. *Anthers* 0.5–0.7 mm high, *c.* 0.35 mm wide. *Style* 20–24 mm long, 0.4–0.5 mm wide at base, with basal *c.* 2 mm inserted in a depression; stigma 0.4–0.8 mm diam. *Fruit* almost fully inferior, 7–8 mm long, 9–10 mm diam.; placentas 3–4 mm long, up to 3.5 mm wide. *Seeds* 2.4–2.6 mm long, 0.7–1 mm wide, 1.4–1.6 mm thick; inner surface with a portion raised 0.2–0.3 mm high around a cavity 0.5–0.7 mm long. *Chaff pieces* paler and smaller than the seeds. Native Pomegranate. (Figure 1)

Selected specimens examined. WESTERN AUSTRALIA: 5.4 km N of Latham on Mullewa Road, 15 Oct. 1982, *J. Coleby-Williams* 232 (PERTH); near Lake Monger [Mongers Lake], 2 Dec. 1958, *C.A. Gardner* 12028 (PERTH); 2 miles [3 km] ENE of Kulja, 13 Nov. 1971, *A.S George* 11178 (AD, CANB, K, MEL, NSW, all *n.v.*, PERTH); 3 km N of N end of Helena and Aurora Ranges, 4 Dec. 1981, *G.J. Keighery* 4414 (PERTH); Kirkalocka Station *c.* 60 km S of Mount Magnet, 18 May 2006, *B. Moyle* 67 (PERTH); Wogarl East Rd, 1–2 km E of Wogarl, NE of Narembeen, 4 Nov. 2004, *B.L. Rye* 241155 *& M.E. Trudgen* (PERTH); 6.25 km NNE of Hyden–Norseman Road on Mt Holland Track, 5 Nov. 2004, *B.L. Rye* 241169 *& M.E. Trudgen* (PERTH).

Distribution and habitat. Extends from Kirkalocka Station west to near Latham and south to the Forrestania area (east of Hyden), usually occurring with varied sandplain species, with many records from yellow sand, often in very species-rich communities. (Figure 3A)

Phenology. Flowers mainly September–November.

Typification. None of the types cited above has been examined directly but photographs or scanned images are available for all of them except for the holotype of *Cheynia pulchella*, which is presumed to be in Dublin at TCD. The Kew specimen considered to be the holotype of *Balaustion pulcherrimum* is the only one that is stamped 'Herbarium Hookerianum'. One of the isotypes from Kew was indicated as being from Bentham's collection.

Notes. The leaves of *Balaustion pulcherrimum* sometimes have a distinct narrow white border formed by the margins and also a white keel; this is particularly well marked on *G.J. Keighery* 4414. Leaves in whorls of three are present on some stems of *W.E. Blackall s.n.* Sep. 1929 but have not been observed elsewhere.

Flower length sometimes appears to vary considerably on a single specimen, and a specimen from Bodallin has the shortest hypanthium measured, *c.* 9 mm long. Flower diameter varies according to whether or not the petals open to a fairly erect position or are widely spreading, but is generally in the range of 15 to 25 mm. The sepals in each flower are of distinctly different lengths, the longer ones *c.* 3 mm long and shorter ones *c.* 2 mm long, only the longer ones measured above. Stamens are particularly long, up to 11 mm, in a specimen from near Yellowdine.

Cheyniana Rye, *gen. nov.*

Frutices humiles. Flores in axillis foliorum solitarii. Pedunculi modice longi. Bracteolae 2, oppositae, saepe persistentes. Pedicelli absentia vel pedunculis breviora. Hypanthium aliquantum tubulare. Petala 5, aurantiaca vel rosea vel rubra. Stamina 30–60 in seriebus 1 vel 2 circulum singularem vel duplus formantes; filamenta longiora filiformia, glanduloso-tuberculata. Antherae parvae, ± globulae; glans connectivi non libera intra antheram conjunctae. Ovarium 2- vel 3-loculare; ovula 10–20 per placentam, radialiter disposita. Stylus longus, basis in depressione centrali inserta. Fructus pariete crassissimo, magnopere inferior, indehiscens, ± globularis.

Typus: *Cheyniana microphylla* (C.A.Gardner) Rye

Shrubs usually low and spreading, less than 1 m high, single-stemmed but often becoming multi-branched at base, glabrous, with leaves mostly densely arranged. *Stipules* absent or inconspicuous. *Leaves* opposite, decussate, very small, smooth or tuberculate, with a very short but well defined petiole;

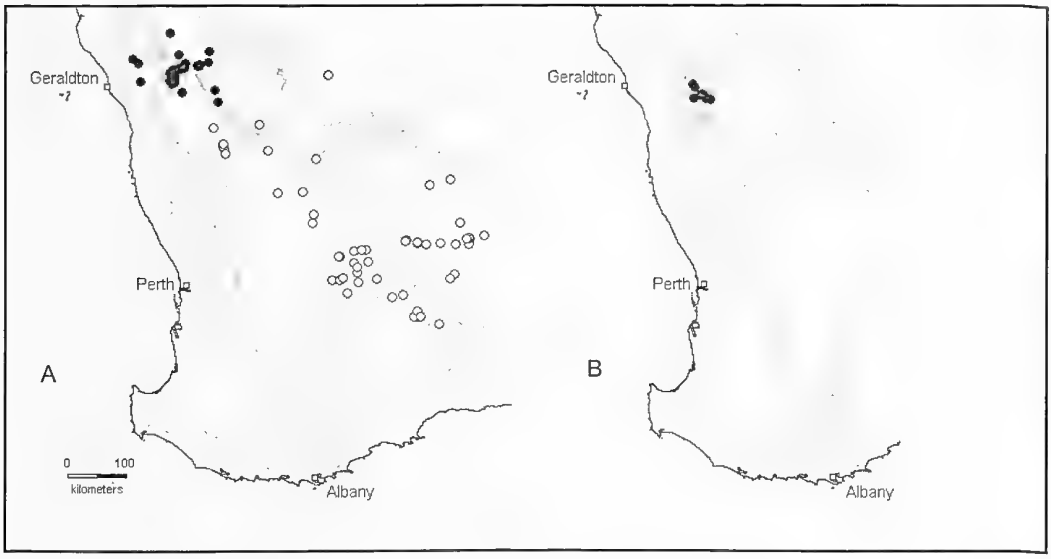

Figure 3. Distribution maps. A – *Balaustion pulcherrimum* (○) and *Cheyniana microphylla* (●). B – *Cheyniana rhodella* (●).

blade narrowly oblong in outline to circular, up to 3 mm long, with glands obvious. *Flowers* solitary in leaf axils, with 1 or several decussate pairs per branchlet. *Peduncles* moderately long, terminated by two bracteoles. *Bracteoles* opposite, often persistent. *Pedicels* absent or shorter than peduncles, up to 2 mm long. *Flowers* usually 10–16 mm diam. *Hypanthium* narrowly obconic to urceolate, 2–8 mm long, bearded or with prominent glands. *Sepals* 5, persistent in fruit, somewhat herbaceous, with thickened keel often ridged or horned. *Petals* 5, shed before fruit matures, large, very shortly clawed, very broadly obovate to more or less circular, pink or orange to red. *Antipetalous processes* minute or absent. *Stamens* 30–60 in one or two circular series, those directly opposite the petals longest, with those of outer series (if present) also longer than adjacent ones of inner series; staminodes absent. *Filaments* filiform, more or less terete, tapering to apex, the longest ones distinctly glandular-tuberculate. *Anthers* dorsifixed, small, ± globular, dehiscent by 2 basally divergent to almost transverse, short slits or pores; connective gland fused between and not extended beyond the thecae. *Ovary* inferior but with a dome or lip raised at centre of disc, 2- or 3-locular; placentation axile, placentas shortly cylindrical to conic, with a short thick attachment; ovules 10–23 per placenta, arranged radially. *Style* slender, terete, base inserted in central depression on disc, largely exserted; stigma small, capitate or peltate. *Fruit* very thick-walled, woody, largely inferior, indehiscent, ± globular. *Seeds* (where known) somewhat facetted, *c.* 1.5 mm long; hilum small.

Etymology. This genus commemorates George McCartney Cheyne (1790–1869) and his wife, who were pioneers in the Albany area. It was Drummond's intention to name the genus *Balaustion* after the Cheynes, who had shown him warm hospitality, accommodating him on their property at Cape Riche and assisting him in obtaining supplies and in the transport of his specimens to Albany. They also assisted others, such as the visiting German botanist Ludwig Preiss in 1840 and the Irish botanist William Harvey in 1854 (Ducker 1988). However, Drummond's proposed generic name *Cheynia* was not validly published until several years after the genus had been named *Balaustion*.

Notes. The two species have obvious morphological differences, many of which are related to their different pollinators, but have an underlying similarity in morphology that indicates a close relationship between them. The floral differences between them are similar to those found between insect-pollinated and bird-pollinated members of genera such as *Darwinia* Rudge and *Verticordia* DC. Their shared characters include their colourful flowers of a similar size (the insect-pollinated ones broader and shallower though), similar stamen filaments (tuberculate-glandular and slender) and anther morphology, and an indehiscent fruit with very hard, thick walls. Leaves may become silvery with age in both taxa.

Key to species of *Cheyniana*

1. Hypanthium 4–8 mm long, bearded. Petals yellowish to red, usually orange. Ovary 3-locular..... **C. microphylla**
1: Hypanthium *c.* 2.5 mm long, glabrous. Petals pink. Ovary 2-locular..... **C. rhodella**

1. Cheyniana microphylla (C.A.Gardner) Rye, *comb. nov.*

Balaustion microphyllum C.A.Gardner, *J. Roy. Soc. Western Australia* 13: 66–67, t. 25I–L (1927). *Type*: near Koolanooka, September, *H.V. Throssell s.n.* (*lecto*: illustration tab 25I–L, here selected).

Illustrations. Blackall & Grieve (1980: 88); Gardner (1927: 66, plate 25I–L) [both as *Balaustion microphyllum*].

Shrub 0.1–0.3(0.45) m high, commonly 0.5–1 m wide. *Petioles* 0.15–0.25 mm long. *Leaf blades* broadly obovate to circular, 1.3–2.3 mm long, 1.2–1.6 mm wide, not very thick except for the prominent keel, apex broadly obtuse with the keel incurved and often with a subterminal mucro, often broadly denticulate to laciniate on the narrow scarious margins, the longest projections 0.1–0.2 mm long; abaxial surface with black oil glands up to 0.15 mm diam. in 2–4 main rows, innermost rows commonly with 5–7 glands; adaxial surface shallowly v-shaped in transverse section, with oil glands less obvious. *Inflorescence* of 1 or 2 separated pairs of flowers per branchlet. *Peduncles* 2–4.5 mm long, 1-flowered, often dark red. *Bracteoles* persistent, broadly ovate to depressed-ovate, 1.2–2.2 mm long, 1.4–2.2 mm wide, scarious except for thickened centre or sometimes more leaf-like, strongly and narrowly keeled; scarious margins often red-tinged, with the laciniate white outer part up to 0.5 mm wide. *Pedicels* sometimes almost absent but usually 0.5–2 mm long. *Flowers* usually 10–14 mm diam. *Hypanthium* urceolate, 4–8 mm long, 4–6 mm diam., yellowish at first, turning orange-red and eventually deep red, bearded, the longest hairs near base or near middle of hypanthium and 0.8–2 mm long; free part 2–5 mm long. *Sepals* fairly erect, very broadly oblong to depressed-ovate, 1–1.7 mm long, 1.5–3 mm wide, with keel very strongly ridged or distinctly horned, largely herbaceous, green or sometimes reddish-tinged, with a scarious white laciniate margin 0.2–0.6 mm wide; horn 0.3–0.7 mm long. *Petals* somewhat or fairly widely spreading, often with inner surface concave (and outer surface convex), 4.5–6 mm long, yellowish orange to deep red, margin laciniate-toothed. *Stamens* numerous, commonly 50–60 in two series, those of outer series with a broader base and tending to be contiguous, those of inner series often having distinct gaps between them at the base. *Longest filaments* 3–6 mm long, glandular-tuberculate, often compressed at extreme base. *Anthers* globular to broadly reniform, *c.* 0.25 mm long, *c.* 0.35 mm wide; thecae facing inwards, basally divergent or almost transverse, dehiscent by a short slit or elliptic pore. *Ovary* 3-locular; ovules 16–23 per loculus, in a circle around a broad placenta. *Style* 8–13 mm long, with basal *c.* 3 mm inserted in a depression; stigma capitate or peltate, 0.25–0.35 mm diam. *Fruit* over half and up to *c.* 4/5-inferior, ± globular, 5–7 mm long

excluding and 7–13 mm long including hypanthium and calyx, 5.5–6.5 mm diam., with style often persistent; hypanthium bearded with hairs up to 3 mm long; placentas like a thick rod, 2–9-seeded. *Seeds* almost semi-circular from side view, very rounded on back and round top to the narrow flatter central face with a central hilum, with flat portions on the sides adjacent to the chaff but not particularly angular, 1.4–1.7 mm long, 0.6–0.8 mm wide, 0.8–1 mm thick, smooth, shiny, medium yellow-brown, the testa thinly crustaceous; hilum broadly elliptic, *c.* 0.25 mm long. *Chaff pieces* not very crustaceous, either very compressed or broader and irregularly shrunken, dark brown with hilum not obvious. Bush Pomegranate. (Figure 2A–E)

Selected specimens examined. WESTERN AUSTRALIA: W side of bitumen road between East Yuna and Yuna, 19 Aug. 1984, *A.C. Burns* 19 (PERTH); Bullardoo Station near the Mullewa road, 15 Aug. 1960, *S.J.J. Davies s.n.* (PERTH); Tardun, 26 Aug. 1948, *J.B. Cleland s.n.* (AD); 95–96 mile peg, Yalgoo–Mullewa, 12 Aug. 1971, *H. Demarz* D3308 (KPBG, PERTH); 17.9 km SE of Mullewa on Mullewa–Morawa road, 4 Oct. 1988, *J.M. Fox* 88/158 (PERTH), near Pindar, 8 Dec. 1958, *C.A. Gardner* 12032 (PERTH); 3 miles [5 km] W of Pindar on Geraldton–Mount Magnet road, 21 July 1953, *R. Melville & J. Calaby* 4260 (PERTH); Barnong Station, on track to CALM section, 5 Oct. 1999, *M. Officer* B2 (PERTH); Yuin–Pindar road, 3.8 km S of Tallering, 5 Aug. 1995, *S. Patrick* 2413 (PERTH); Mellenbye Station, 17 Aug. 1993, *A.L. Payne* 3786 (PERTH); 2.55 km E of Docherty Road on Geraldton–Mount Magnet road, 9 Sep. 2003, *B.L. Rye* 239054 *& M.E. Trudgen* (CANB, NSW, PERTH); 8.73 miles [14 km] S of Narloo Homestead, 27 Oct. 1984, *B.H. Smith* 512 (PERTH).

Distribution and habitat. Extends from Bullardoo Station (north of the upper Greenough River) south-south-east to Mellenbye Station, north-east of Morawa. Occurs in rich sandplain vegetation, often in yellow or orange sand. (Figure 3A)

Phenology. Flowers mainly August to October, with fruits mainly from September to December.

Conservation status. Known from a large number of collections in an area *c.* 130 km long. It has been adequately surveyed.

Lectotypification. The type specimen of this species is missing. According to Gardner (1927) it was collected by Hugo V. Throssell and was lodged at the Department of Agriculture. It should, therefore, have become part of the collection of the Western Australian Herbarium, but the earliest collections of the species currently lodged at PERTH were made in 1928. Fortunately, Gardner included a good illustration of the species in the protologue and so that is selected here as the lectotype of the taxon.

Affinities. See notes under *Cheyniana rhodella.*

Notes. This species has the highest stamen number known for the *Hysterobaeckea.* This number is also higher than in most other lineages of tribe Chamelaucieae, although exceeded by some of the species of *Hypocalymma* and by many members of subtribe Calytricinae. The arrangement of the stamens in two series in *Cheyniana microphylla* is similar to that seen in other members of the Chamelaucieae with large numbers of stamens.

Some characters, such as petiole length, show very little variation between specimens of *Cheyniana microphylla*, while others, such as hypanthium length, are extremely variable.

Blackall and Grieve (1980: 88) and Corrick *et al.* (1996: 112) give the common name Bush Pomegranate for this species while Keighery (2004) gives the same common name, Native Pomegranate, as for *Balaustion pomaderroides*. Different common names are clearly needed now that the two species are in different genera. The name Bush Pomegranate, which is accepted here as the common name for *Cheyniana microphylla*, seems appropriate as this species has similar-looking flowers to those of *Balaustion* but differs in its more bushy habit.

2. Cheyniana rhodella Rye & Trudgen, *sp. nov.*

Cheyniana microphyllae affinis sed floribus brevioribus glabris, petalis roseis, staminibus et ovulis paucioribus, et ovario 2-loculari differt.

Typus: north of Morawa, Western Australia, 23 October 1986, *M.E. Trudgen* 5387 (*holo:* PERTH 06218857; *iso:* CANB, K, MEL, NSW).

Baeckea sp. Mullewa–Morawa (A.C. Burns 24), Western Australian Herbarium, in *FloraBase* http://florabase.dec.wa.gov.au [accessed July 2007].

Shrub moderately dense, 0.3–0.8 m tall, up to 1 m across, much branched, with leaves widely spreading to appressed, fairly dense on small branchlets, distant on flush growth. *Petioles* 0.2–0.3 mm long. *Leaf blades* narrowly oblong to more or less elliptic in outline, 1.5–3 mm long, 0.5–1.1 mm wide, 0.25–0.4 mm thick, apex obtuse; abaxial surface shallowly convex, with very prominent oil glands in 1–3 main rows of 4–8 glands up to 0.3 mm diam.; adaxial surface flat or slightly concave, with oil glands less prominant. *Inflorescence* of 1–3 pairs of flowers per branchlet. *Peduncles* 0.8–1.2 mm long, 1-flowered. *Bracteoles* caducous to persistent, ovate to very broadly ovate, 0.7–1.9 mm long, 0.9–1.6 mm wide, somewhat scarious, entire. *Pedicels* almost absent or up to 0.6 mm long. *Flowers* 11–16 mm diam. *Hypanthium* narrowly obconic, *c.* 2.5 mm long, 2.5–4 mm diam., red-tinged, adnate part fairly smooth but often with longitudinal lines; free part *c.* 1 mm long, often with somewhat prominent glands. *Sepals* spreading to fairly erect, depressed ovate to almost triangular, 0.8–1.5 mm long, 1.3–2 mm wide, with incurved keel thickened or ridged, largely herbaceous and reddish, with a narrow scarious margin 0.1–0.3 mm wide, entire, with prominent oil glands. *Petals* widely spreading, 5–7 mm long, pink or mauve-pink, rather broad-based, margin finely laciniate or entire. *Stamens* 30–46 in a single series, some of them often contiguous at the base but always with some distinct gaps in the circle. *Longest filaments* 1.5–2.2 mm long, with a few tuberculate glands, reddish. *Anthers* subglobular to reniform, 0.2–0.3 mm long, 0.25–0.35 mm wide, the pores elliptic or narrowly elliptic; connective gland not extended beyond the thecae. *Ovary* 2-locular, inferior but with a central dome equalling hypanthium rim; placentas cylindrical to conic with top truncate, more or less sessile by a circular central attachment; ovules 10–15 per loculus, arranged radially. *Style* slender, terete, 2.2–2.6 mm long, with basal 0.3–0.8 mm inserted in a depression; stigma capitate, up to 0.1 mm diam. *Immature fruit* 2/3–3/4-inferior, almost ellipsoid, *c.* 3 mm long, *c.* 2.7 mm wide excluding and *c.* 4.5 mm wide including the calyx, thick-walled; hypanthium shallowly but distinctly irregularly longitudinally patterned; disc convex, deep maroon. (Figure 3F–I)

Other specimens examined. WESTERN AUSTRALIA: Canna area, 6 Sep. 1963, *A.M. Ashby* 335 (AD); between Mullewa and Morawa, 6 Oct. 1984, *A.C. Burns* 24 (PERTH); NE of Mingenew, 12 Sep. 1992, *A. Carr* 114 (PERTH); between Mullewa and Morawa, 1 Oct. 1981, *L.A. Craven* 7013 (PERTH); between Mullewa and Morawa, 10 Sep. 1963, *A.R. Fairall* 1379 (KPBG *n.v.*, PERTH); W of Canna, Sep. 1981, *W. Kullman* S4779 (KPBG *n.v.*, PERTH); between Mullewa and Morawa,

2 Oct. 1962, *F. Lullfitz* L1193 (KPBG, PERTH); Gutha area, 10 Sep. 1985, *F.W. & T.E. Phillips s.n.* (PERTH); S of Tardun, 1 Oct. 1962, *M.E. Phillips* WA/62 1700 (CBG *n.v.*, PERTH).

Distribution and habitat. Occurs in an area north-east of Morawa, extending from near Tardun south-west to Gutha and south to half way between Mingenew and Canna. It is associated with gravel, recorded for example in red sandy soil over gravel, the type specimen from yellow-brown sandy loam in *Hakea* and *Acacia* scrub to closed scrub. No other specimens have vegetation details recorded. (Figure 3B)

Phenology. Flowers: September to October.

Conservation status. Recently listed as Priority Two under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora. This species is geographically restricted, known from an area *c.* 60 km long and almost as wide. It is not known from any conservation reserves and the small number of collections of the highly attractive species suggests that it may be at risk; it certainly needs to be surveyed. The most recent collection was made from private property in 1992.

Etymology. From the Greek *rhodellus* (rose-coloured, pale pure red), referring to the beautiful pink flowers of this species.

Affinities. Differs from its closest relative *Cheyniana microphylla* in many characters, including its narrower leaves with more prominent oil glands, its glabrous rather than bearded hypanthium and its 2-locular ovary with fewer ovules per loculus.

Cheyniana rhodella has a small geographic range that overlaps with the much larger range of *C. microphylla.* There are no records of the two species occurring in very close proximity and differences in their habitat preferences may keep them separated for the most part.

Notes. As *Cheyniana rhodella* was recognised as a distinct species and allocated the informal name *Baeckea* sp. Mullewa–Morawa (*A.C. Burns* 24) by Malcolm Trudgen, he is jointly an author of this species.

Minute antipetalous processes are often present in this species but appear to be absent in *Cheyniana microphylla.* Mature fruits and seeds are needed to complete the description given here for *C. rhodella.* Immature seeds or chaff pieces are flat and wedge-shaped with a rounded back.

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Reinstatement of the Western Australian genus *Oxymyrrhine* (Myrtaceae: Chamelaucieae) with three new species

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Abstract

B.L. Rye. Reinstatement of the Western Australian genus *Oxymyrrhine* (Myrtaceae: Chamelaucieae) with three new species. *Nuytsia* 19(1): 149–165 (2009). The south-western Australian genus *Oxymyrrhine* Schauer is reinstated and the type species, previously known as *Baeckea polyandra* F.Muell., is restored to its earlier name of *O. gracilis* Schauer. A lectotype is selected for *B. polyandra* and three new species, *Oxymyrrhine cordata* Rye & Trudgen, *O. coronata* Rye & Trudgen and *O. plicata* Rye & Trudgen, are described. These four species make up a group described here as *Oxymyrrhine s. str.* and are distinguished from other members of *Oxymyrrhine s. lat.* and from all other genera of tribe Chamelaucieae by the broad cavity in the summit of their fruit. *Oxymyrrhine s. lat.* includes a particularly difficult species complex, which will be revised at a later time.

Introduction

Oxymyrrhine Schauer is a south-western Australian genus belonging to tribe Chamelaucieae *s. lat.* of the Myrtaceae. The genus was named by Schauer (1843) based on the single species *O. gracilis*, which Mueller (1864) later redescribed as *Baeckea polyandra*. Schauer appears to have relied on the numerous stamens and the anther type to define *Oxymyrrhine*, while Mueller was the first to describe fruiting material, recording that the capsule was enclosed (not protruding) and the seeds were small, brown and trigonous-semicircular.

In *Flora Australiensis*, Bentham (1867) treated the genus as a section of his very broadly defined genus *Baeckea* L. Since the epithet of the type species of *Oxymyrrhine* had already been used in *Baeckea s. lat.*, it was necessary for the later-published name *Baeckea polyandra* to be accepted for the species. Bentham listed five south-western Australian species in *Baeckea* sect. *Oxymyrrhine*, adding *Baeckea crispiflora* (F.Muell.) F.Muell., *B. corynophylla* (F.Muell.) F.Muell. and two species closely allied to the latter. Niedenzu (1893) recognised six species within *Oxymyrrhine*, which he maintained as a section but included within his new group *Baeckea* subgenus *Hysterobaeckea* Nied. All members of the *Hysterobaeckea* group have a derived anther type with the connective gland united to other parts of the stamen.

DNA samples collected as part of the current study included the type species of *Oxymyrrhine* and a Darling Range species that was described as *Baeckea* sp. A in *Flora of the Perth Region* (Rye 1987). In unpublished analyses based on several chloroplast regions (the *mat*K gene, the 5' *trn*K intron, part of

the *ndh*F gene and the *atp*B-*rbc*L intergenic spacer), these two species formed a well-supported clade (Peter Wilson pers. comm.). When the ETS nuclear region was examined, the two species remained together and formed part of a much larger clade comprising taxa with the *Hysterobaeckea* anther type, including members of the *Baeckea crispiflora* complex. The unpublished data suggest that additional genera including *Oxymyrrhine* should be recognised, but currently do not provide any strong support for the inclusion of the *B. crispiflora* complex within *Oxymyrrhine*.

Oxymyrrhine is reinstated in the current paper, and three new closely related species that were unknown to the nineteenth century botanists are named. These four species are referred to here as *Oxymyrrhine s. str.* Revisionary studies of other species groups that were included in section *Oxymyrrhine* by Bentham (1867) are not far enough advanced to estimate how many species should be recognised. The *Baeckea crispiflora* complex is particularly problematic, and the name *B. crispiflora* may have to be discarded as three earlier species epithets (*leptophylla*, *parvifolia* and *serpyllifolia*) published by Turczaninow (1852) apply to members of the complex.

Methods

Descriptions are based on well-pressed dried material, using similar methods to those described in other recent papers on Western Australian Chamelaucieae such as Rye (2002). Holotypes for the new species have been lodged at PERTH. For those species with conservation priority, precise localities have been withheld for all specimens cited. The distribution map was compiled using DIVA-GIS freeware Version 5.2.0.2.

Reinstatement of *Oxymyrrhine*

It has long been acknowledged that one or more genera with the *Hysterobaeckea* anther type should be reinstated (see Johnson & Briggs 1984, Rye 1987 and Lam *et al.* 2002), and the eastern Australian species of the *Hysterobaeckea* have already been removed from *Baeckea* (Bean 1997, Wilson *et al.* 2007). Despite this, not even the oldest available name, *Babingtonia* Lindl. (Lindley 1842), has been used since Bentham's time for members of the group in Western Australia. Shortly after *Babingtonia* was established, Schauer (1843) described three more genera belonging to the *Hysterobaeckea* group: *Oxymyrrhine*, *Harmogia* Schauer and *Tetrapora* Schauer. Since then, a number of additional generic names have been published, those currently in use being *Balaustion* Hook., *Kardomia* Peter G.Wilson, *Malleostemon* J.W.Green, *Sannantha* Peter G.Wilson and *Scholtzia* Schauer, and an additional genus, *Cheyniana* Rye, is published in the accompanying paper (Rye 2009).

Comparison with *Babingtonia, Harmogia* and *Tetrapora*

For *Oxymyrrhine* to be reinstated it must first be established that the type species of *Babingtonia* and *Oxymyrrhine* are not congeneric, since the earlier name *Babingtonia* has priority. A paper (jointly authored with M.E. Trudgen) reinstating *Babingtonia* as a Western Australian endemic genus is currently in preparation. *Babingtonia* was previously treated by Bean (1997) as the sole generic name for eastern Australian species of the *Hysterobaeckea* group; however this very broad definition of the genus has not been supported by molecular data (Lam *et al.* 2002, Wilson *et al* . 2004) and most of the eastern species have now been placed in two new genera (Wilson *et al.* 2007). The type species of *Babingtonia*, *B. camphorosmae* Lindl., and its closest relatives occur in the south-west of

Western Australia and are readily distinguished from *Oxymyrrhine* by their more compressed stamen filaments, by their helmet-like anthers, which vary from compressed-obovoid to deeply divided into two divergent lobes and which often have two longitudinal lateral grooves, and by their longer and much thicker seeds with a more flattened base and more angled summit.

One of the two genera named concurrently with *Oxymyrrhine*, the monotypic eastern Australian genus *Harmogia*, has recently been reinstated (Wilson *et al.* 2007). Cladistic data presented in that paper suggest that *Harmogia* is most closely related to the eastern Australian taxa now placed in the new genus *Sannantha*. Bentham (1867) placed the members of these genera in *Baeckea* sect. *Harmogia* (Schauer) Benth. & Hook.f. *Harmogia* differs from *Oxymyrrhine* in having its seeds flattened at the base rather than curved at both ends like the segments of an orange as in *Oxymyrrhine* and has a testa of flat to concave cells which are much larger than the colliculate cells on seeds of *Oxymyrrhine*. It also shows subtle differences in its anther morphology, with its connective gland extending dorsally not only well beyond the anther loculi but also down beyond the top of the free part of the filament. A more obvious difference is its tendency to have very dense clusters of leaves on its lateral branchlets.

Unlike *Harmogia*, the other concurrently named genus, *Tetrapora*, has not yet been reinstated and its delimitation and morphology have not been fully determined. Bentham (1867) placed the members of the genera *Tetrapora* and *Babingtonia* in *Baeckea* sect. *Babingtonia* (Lindl.) Benth. & Hook.f., and molecular data (Wilson *et al*. 2004) place them in the same clade, together with species of *Malleostemon* and *Scholtzia*. *Tetrapora* can be distinguished from *Oxymyrrhine s. str.* by its tendency to have multiple flowers per axil, by its less numerous stamens (5 to 14 per flower), which are all antisepalous, and by its more tubular depression in the ovary summit. Establishing character differences between *Tetrapora* and *Oxymyrrhine s. lat.* is deferred until both groups have been studied further.

Delimitation of *Oxymyrrhine*

The type species of *Oxymyrrhine* and its three closest relatives, i.e. the members of the typical group referred to here as *Oxymyrrhine s. str.*, are characterised by a deep and distally-expanded depression in the summit of the mature dried fruit, which remains fully or almost fully inferior. This broad cavity is also evident in the ovary summit of flowers in all dried material, exposing the part of the style that is below the summit of the ovary. Other genera of tribe Chamelaucieae either lack a deep cavity or have a tubular one closely surrounding the lower part of the style. In the typical group of *Oxymyrrhine* the base of the depression is sometimes contracted into a very short tubular portion closely surrounding only the extreme base of the style. At maturity, the style may either remain included within the cavity or become exserted from it. All of the species that were added to the *Oxymyrrhine* group by Bentham, such as the *B. crispiflora* complex, differ from the typical group in having the style base closely enclosed within a cylindrical depression.

A second character separating *Oxymyrrhine s. str.* from all other species placed in the group by Bentham is the arrangement of the stamens in a complete ring rather than just opposite the sepals. Although not fused to one another, the short thick stamens are arranged in a complete ring occupying all positions with little or no separation of the filaments. Other members of the *Hysterobaeckea* group differ from this, either by having the stamens in different arrangements, most often grouped opposite the sepals, or, if the stamens form a complete circle, by having longer stamens which may also differ in having either a more filiform filament or a more compressed one.

In 1994, Malcolm Trudgen allocated informal names to two of the new species of *Oxymyrrhine s. str.*, treating both as subspecies of *Baeckea crispiflora*. This resulted (pers. comm.) from his desire

to recognise a relationship between these taxa and the *B. crispiflora* group although he was well aware that they were actually distinct species. Since then I have allocated another informal name, *Baeckea* sp. fine-leaved (C.M. Lewis 517), to a very distinct new species that had also been housed under the name *B. crispiflora*.

Members of the *Baeckea crispiflora* complex are like *Oxymyrrhine s. str.* in having solitary axillary flowers and persistent bracteoles that are often not strictly opposite, and they have a similar texture to the hypanthium. However, members of the *B. crispiflora* complex are distinguished by their longer and more exserted stamens, which are arranged opposite the sepals (i.e. none opposite the centre of each petal) with gaps between the filaments, their more or less sessile placentas, their red style with a very large peltate stigma, and their fruit with a convex summit extending slightly above the level of the adnate part of the hypanthium.

Baeckea sp. fine-leaved (C.M. Lewis 517), which was treated by Bentham (1867: 86) under the misapplied name *Baeckea pulchella* DC., is somewhat intermediate between *Oxymyrrhine s. str.* and the *B. crispiflora* complex in its stamens, which are short like those of the former but arranged opposite the sepals as in the latter. It differs from both groups in several vegetative characters, having sessile leaves, strictly opposite bracteoles, and a very prominent stem flange subtending both the leaves and bracteoles. Its pedicel is long in comparison with that of *Oxymyrrhine s. str.*, and its placentas have a shorter stalk. Its seeds are smaller than in both *Oxymyrrhine s. str.* and the *B. crispiflora* complex, especially the latter. Its anther loculi are more closely fused than in *Oxymyrrhine s. str.* as there is no clear line of demarcation between them. In this respect *Baeckea* sp. fine-leaved seems to be closer to the *B. crispiflora* complex, which it certainly matches in having its style in a cylindrical rather than in a distally expanding depression. Another shared characteristic is the tetraploid chromosome number of n=22 (Rye 1979) found in *B.* sp. fine-leaved (voucher specimen *B.L. Powell* 74108) and members of the *B. crispiflora* complex (many vouchers including *B.L. Powell* 74062 & 74068), but the chromosome numbers of the four species of *Oxymyrrhine s. str.* are unknown.

Members of the *Baeckea corynophylla* group, which Bentham (1867) also included in sect. *Oxymyrrhine*, show even greater differences from *Oxymyrrhine s. str.* than those discussed above, for example in their tendency to produce multiple flowers per axil. A key given in this paper shows only how to separate the four species of the typical group from one another and from the two taxa that appear to show the greatest morphological similarity, *Baeckea* sp. fine-leaved and the *B. crispiflora* complex.

Although the precise limits of *Oxymyrrhine* have yet to be determined, the three new species described here all clearly belong within it. Reinstatement of the genus is necessary to allow these species to be named under their correct generic name rather than in *Baeckea s. lat.*

Morphology

Habit and leaves. The four species of *Oxymyrrhine s. str.* are small glabrous shrubs, up to a maximum height of 1 m, varying from very spindly and straggling plants growing through (and supported by) dense vegetation, to plants that are fairly dense and erect without any support. Oil glands are not particularly prominent on the vegetative organs, although they are sometimes prominent on the disc, hypanthium and style.

The leaves have a short but distinct petiole, the lamina varying from very thickened (but indented on the adaxial surface) to flat, and from linear in outline to obovate or cordate. Only *Oxymyrrhine cordata* has cordate leaves (Figure 1A); this is an uncommon leaf shape in the tribe Chamelaucieae as a whole and makes *O. cordata* relatively easy to identify from vegetative material.

Inflorescence. Flowers are solitary in the axils, with a peduncle up to 6 mm long below the pair of bracteoles. The hypanthium may be sessile within the bracteoles or separated from them by a short pedicel. Often the bracteoles are somewhat displaced from one another (e.g. Figure 1B) rather than strictly opposite. They are persistent at anthesis and tend still to be present when the fruit dehisces. The rather leaf-like sepals have the main protective function of the flower buds rather than the two bracteoles, which only cover a small proportion of the sides of the bud.

Flowers. In *Oxymyrrhine* the flowers are small, with a diameter usually between 5 and 10 mm. The hypanthium is obconic in young buds, but becomes more or less hemispheric in older buds and flowers, maintaining this shape or becoming more 3-lobed (the lobes formed by the swelling of the three loculi) in the fruits. It is dotted with oil glands and sometimes has antisepalous ribs in the flowering stage but tends to become smoothed out as the fruit expands. The sepals are generally folded and, for this reason, appear more ribbed than the hypanthium does.

The sepals are moderately large and are quite distinctive in each species of *Oxymyrrhine s. str.*, although all are stiff erect structures that persist as points above the fruiting hypanthium, giving the fruits a crown-like appearance (Figure 1B, H & O). *Oxymyrrhine cordata* differs from the other three species in having an erect dorsal horn that is much longer than the scarious incurved apex of the sepal (Figure 1C). The other three species have no horn, although their sepals may at first sight appear to be horned. *O. plicata* is distinguished from the other species in that its almost entirely herbaceous sepals are folded flat and tend to be somewhat spreading rather than erect (Figure 1P). In *O. coronata* the sepals are also folded, but not so closely so, and differ from those of the other three species in having the base of the folded part pinched in (Figure 1D–F & H). The sepals of the last species, *O. gracilis,* are more open still (Figure 1L) and so are broader than those of the other three species.

Oxymyrrhine has some minute filiform structures inserted between the petals and stamens. These are referred to in the generic description and accompanying paper (Rye 2009) as antipetalous processes.

Androecium. As illustrated in Figure 1E & K, the short stamens are indefinite and inserted in a single circular series, with the bases of the filaments either abutting each other or separated by only a short gap. The filaments opposite the petals tend to have broader and longer filaments than those opposite the sepals, with stamens that are intermediate in position being also intermediate in size. Occasionally one of the antisepalous stamens is reduced to a staminode, but most flowers lack staminodes.

All filaments are incurved in bud. Antipetalous stamens uncurl and extend inwards and then dehisce shortly after the flowers open and tend to be shed early in the fruiting stage. Antisepalous stamens, which extend inwards and dehisce at a later stage, are retained for longer as the fruit matures. Consequently, in the early fruiting stage only antisepalous stamens may be left, with long gaps where the antipetalous stamens have been shed.

The pale-coloured filaments are rather thick and fleshy-looking and their surface generally appears minutely textured in pressed specimens, perhaps as a result of shrinkage during drying. Mostly they

appear to be more or less terete but those opposite the petals sometimes appear to be somewhat flattened at the base. Sometimes a filament is very narrowed at its attachment to the anther while at other times, often in the same species, it is rather broadly attached to the anther. In both cases the anther seems to be firmly attached, not versatile.

Anthers. Each anther faces into the centre of the flower, with pollen shed from two slits on its inner surface and the filament attached at or near the base of its outer (dorsal) surface. Prior to dehiscence it is up to 0.4 mm wide and usually distinctly shorter than it is wide, with a swollen dorsal connective gland that is free from the filament but fused on each side to the two thecae (Figure 1G & M). Once the pollen and the oily contents of the connective gland have been shed, the gland is much less obvious and the structure of the anther as a whole becomes difficult to interpret. The anther is smaller and more or less subglobular after dehiscence.

The type species, *Oxymyrrhine gracilis*, differs from the other three species in its anther morphology, having a more obvious connective gland that forms a smooth pale lobe protruding beyond its very dark thecae (Figure 1M). The thecae have obvious long slits that diverge but do not meet at the centre of the anther. In the other three species, the anther has a more flattened connective gland that does not protrude beyond the top of the thecae and there tends to be less contrast in colour between the gland and the thecae. The slits are very widely divergent, not far from forming a straight line, and they more or less meet at the centre of the anther (Figure 1G).

Gynoecium. Each placenta is flat or concave on the inner surface and has a rather long and often closely appressed stalk attached at or just above the centre and extending to its base or just below the base. As it ages the placenta thickens on the outer surface, becoming ridged along the centre or shaped more like a pyramid. It also darkens, usually becoming medium to dark brown, and is then much darker than the stalk. The small, whitish attachment points for the ovules are located around the margin and at the apex, but there tends to be a slight gap in the attachments at the extreme base of the placenta. The ovules are attached right around the perimeter of the placenta and radiate from the centre of it. The centre of the placenta is bare prior to fertilization but post-fertilization enlargement results in the seeds of opposite sides of the placenta being in close contact with one another.

The ovary summit is deeply and broadly hollowed, being almost obconic or having the centre steep and the margins more curved. The style is light green with a capitate stigma that is either paler or similarly coloured. In most taxa the style is both short and sunken, and so is not visible from side view in the flower or fruit. However, *Oxymyrrhine plicata* has a longer style that is somewhat exserted.

Fruit. As previously noted (p. 3), the summit of the inferior fruit of *Oxymyrrhine* has a broad deep depression (Figure 1H), which distinguishes this group from other genera in the Chamelaucieae. The adnate part of the hypanthium is almost hemispheric to depressed cup-shaped, and is somewhat three-lobed, while the disc is rounded inwards over the three valves down to the deep base of the style. The fruit is inferior with the persistent free portion of the hypanthium forming a rim above it capped by the sepals (Figure 1B, H & O). Each of its three loculi has a curved valve that reaches just above the base of the free portion of the hypanthium but also sinks well below that level into the depressed centre of the fruit (Figure 1H). Seed set is generally fairly high, with about half or more of the ovules apparently developing into viable seeds, and with several to many seeds in each loculus.

Seeds. At maturity the seeds are uniformly coloured, either yellowish brown or medium brown, and are 0.6 to 0.8 mm long. They are facetted and fairly regular in shape, not nearly as variable as in some

other genera or species groups, and mostly resemble the segments of an orange (Figure 1I) except that the inner edge is often somewhat flattened into a narrow face. The crustaceous testa is not very thick and has a reticulate pattern of usually slightly convex cells. The hilum is very small and more or less circular.

Distribution and phenology

The four species of *Oxymyrrhine s. str.* occur in the southern part of the South West Botanical Province of Western Australia, from the Darling Range to Cape Arid National Park (Figure 2). *Oxymyrrhine cordata* and *O. plicata* may overlap slightly in the Kulin area, where their known ranges are separated by less than 50 km. However, there is some evidence that they occupy distinct habitats. The combined range of these two species is separated by a disjunction of over 200 km from *O. coronata* in the north-west and a disjunction of over 100 km from *O. gracilis* in the south-east. Flowering is mainly during summer, but in at least two of the species it begins in late spring.

Descriptions and key

Oxymyrrhine Schauer, *Linnaea* 17: 240 (1843). – *Baeckea* sect. *Oxymyrrhine* (Schauer) Benth. & Hook.f., *Gen. Pl.* 1, 701 (1865). *Type*: *Oxymyrrhine gracilis* Schauer

Shrubs up to 1 m high, glabrous, with the leaf-bearing stems tending to be spindly; young branchlets leafy, with a loose, pale grey epidermis shed in strips or patches from darker layer which tends to disintegrate into numerous fibres. *Leaves* opposite, decussate, small, with a very short but well defined petiole; blade linear in outline to obovate or cordate, flat or if thick then with adaxial surface indented; abaxial surface shallowly to very deeply convex or more angled, with 1 to many main rows of oil glands on each side of midvein; adaxial surface concave or with a v-shaped indentation, with oil glands not very conspicuous. *Flowers* nearly always solitary in leaf axils, with 1 or several decussate pairs per branchlet. *Peduncles* short or long, terminated by two bracteoles. *Bracteoles* tending to be slightly to markedly separated rather than being strictly opposite, persistent at anthesis and often in fruit. *Pedicels* short or absent. *Hypanthium* adnate to ovary for most of its length, sometimes with 5 longitudinal antisepalous ribs, dotted with fairly large oil glands; adnate portion broadly obconic (becoming cup shaped in fruit); free portion erect. *Sepals* 5, erect, persistent in fruit, moderately large, fully herbaceous in one species, in the other taxa with a scarious to petaline margin, denticulate to laciniate. *Petals* 5, widely spreading, shed before fruit matures, very shortly clawed, very broadly obovate or more or less circular, white or pink-tinged on inner surface, the portion of outer ones that is exposed in late bud often deep pink. *Antipetalous processes* often numerous, filiform, minute, pale. *Androecium* of 22–34 short stamens in a circle, usually more or less contiguous but occasionally with slight gaps between the antipetalous filaments, those closest to the centre of the petals usually longest and those closest to the centre of the sepals shortest; staminodes rare or absent. *Filaments* strongly incurved inwards and downwards at first, becoming raised to a more horizontal position prior to dehiscence, thick at base and for most of length, tapering at apex to form a slender attachment to the centre of the back of the anther (i.e. appearing to be versatile). *Anthers* small, broader than long, with the two cells closely fused to one another, their junction marked by a narrow groove, and also fused to a connective gland, opening by two slits that diverge basally, either meeting distally or separated on either side of the connective gland. *Disc* rounded on margin and deeply incurved at the centre, dotted with rather large and somewhat raised oil glands, green. *Ovary* 3-locular, fully inferior;

placentas axile, large, peltate, long-stalked, with well-spaced attachment points for the ovules; stalk appressed to placenta, pale; ovules 8–15 per placenta. *Style* terete, very short or of moderate length, in some taxa scarcely exserted from the large depression in the summit of the ovary, sometimes with the base closely surrounded by a very short cylindrical extension of the broad central depression; stigma capitate. *Fruit* dry, fully or largely inferior, with a broad and deep central depression, many-seeded; hypanthium broader than long and somewhat 3-lobed; valves 3, opening to an erect position. *Seeds* radially arranged on the placenta, facetted, usually almost semicircular from side view, with a large and rounded outer surface, two equal lateral surfaces and a small and narrow inner surface or angle, 0.6–0.8 mm long, 0.3–0.5 mm deep (depth greater than width), with a very small circular hilum; testa colliculate or almost so with a very fine pattern of slightly raised (convex) or level cells, brown, often somewhat shiny.

Etymology. Presumably derived from the Greek *oxy* (sharp) and the neo-tropical genus *Myrrhinium* Schott, perhaps because the leaves of the new genus seemed reminiscent of the small coriaceous leaves of *Myrrhinium* but are more acute.

Key to species of *Oxymyrrhine s. str.* and closely related taxa

None of the three new species treated here is included in the key in Blackall & Grieve (1980). All of them would come out, in the combined key to species of *Astartea s. lat.*, *Baeckea s. lat.* and *Scholtzia*, to Section 4 (page 78), which contains a miscellaneous assemblage of species including *Oxymyrrhine gracilis* [as *Baeckea gracilis*]. Right at the start of this section the three new species would be separated from *O. gracilis* because the first character used in the key differentiates between relatively flat-leaved taxa like them and thick- or narrow-leaved taxa such as *O. gracilis*.

The new key presented here is primarily to distinguish the four species described below, but also includes the two taxa with which they are most likely to be confused.

1. Stamens 22–35 in young flowers, in a continuous circle with some antipetalous, the antipetalous ones maturing early and often shed before the antisepalous ones.

2. Leaves linear in outline, thick, with a recurved apical point. Sepals acute and sometimes with a recurved apical point, not horned. Connective gland (before dehiscence) forming a lobe similar in size and shape to those of the 2 dark brown thecae. (Torradup River to Cape Arid National Park) ..... **O. gracilis**

2: Leaves narrowly obovate to cordate, not very thick, often mucronate. Sepals horned or folded and horn-like. Connective gland (before dehiscence) not prominent and often not obvious, more flattened than the thecae.

3. Leaves cordate, entire. Sepals prominently horned. (Corrigin to Toolibin to Kulin)..... **O. cordata**

3: Leaves narrowly obovate to broadly elliptic, with denticulate to laciniate margins. Sepals not horned but folded and often horn-like

4. Leaves 1.8–2.7 mm long, with laciniate margins. Sepals folded flat, not constricted, with very laciniate margins. Filament of longest stamens 0.7–0.8 mm long. Mature style 1.3–1.4 mm long. (Kulin to Frank Hann National Park) ..... **O. plicata**

4: Leaves 3.5–6 mm long, with denticulate margins. Sepals constricted towards base, folded but not flat, serrulate or entire. Filament of longest stamens 0.3–0.5 mm long. Mature style 0.7–0.9 mm long. (Darling Range)..... **O. coronata**

1: Stamens 10–25, in five antisepalous groups of 2–6, none strictly antisepalous.

5. Leaves sessile, thick, not narrowed at base. Stigma very small, capitate. Seeds 0.4–0.65 mm long. (Ballidu to south of Borden and Frank Hann National Park) ..... **B.** sp. **fine-leaved**

5: Leaves much broader than thick, narrowed at base; petiole poorly defined or up to 0.5 mm long. Stigma large, peltate. Seeds 0.8–1.2 mm long. (Yuna to Cheyne Bay to Kalgoorlie and to south of Balladonia) ..... **B. crispiflora** complex

1. Oxymyrrhine cordata Rye & Trudgen, *sp. nov.*

Species foliis cordatis et sepalis manifeste cornutis a congeribus diversa.

Typus: east of Toolibin, Western Australia, 20 December 1998, *P. Rose & G. Warren* 172 (*holo:* PERTH 05394090; *iso:* CANB, K, MEL).

Baeckea crispiflora subsp. Corrigin (A.S. George 14431), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 346 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed July 2007].

Shrub 0.3–1 m high, with widely spreading leaves that are usually not very dense. *Stipules* apparently absent. *Petioles* 0.35–0.6 mm long. *Leaf blades* cordate, 2.5–3.5 mm long, 2.8–3.5 mm wide, not very thick, more or less acute, non-mucronate or with a mucro *c.* 0.1 mm long, margins entire, the keel thickened towards the apex into a ridge and sometimes incurved at apex; abaxial surface dotted with many rows of small oil glands; adaxial surface concave, dotted with numerous oil glands. *Inflorescence* of usually 2–9 pairs of flowers towards end of each branchlet. *Peduncles* 1.5–6 mm long. *Bracteoles* persistent in flower and usually to the mature fruiting stage, narrowly ovate to linear, 1.8–2.5 mm long, 0.3–0.5 mm wide, acute, herbaceous, green, entire. *Pedicels* 0.2–1 mm long. *Hypanthium* 1.5–2.3 mm long, 2–2.5 mm wide, somewhat 5-ribbed; adnate portion somewhat glandular-rugose; free portion *c.* 0.5 mm long. *Sepals* largely consisting of a very prominent horn but also with a very narrow, scarious and minutely laciniate portion orientated inwards at right angles to the horn, *c.* 1 mm long; horn erect, thick, green, with outer surface convex and inner surface concave. *Petals c.* 3 mm long, white. *Androecium* of 25–32 stamens; filaments terete, thick, tapering to a central attachment to the anther, the longest ones 0.6–0.8 mm long. *Anthers* (prior to dehiscence) transversely oblong to transversely broadly subreniform, much broader than long, *c.* 0.25 mm wide, with dark brown cells and a moderately large but not very obvious mid-brown connective gland closely united with the cells; slits meeting at apex, almost forming a line, basally very widely divergent, short. *Ovary* 3-locular; placentas with a pale stalk, becoming pyramid-shaped in fruit; ovules 9–11 per placenta. *Style* 0.8–1 mm long, entirely exposed but sometimes paler towards the base. *Fruit c.* 1.5 mm long excluding calyx and 2.3–2.5 mm long including calyx, 2–2.5 mm diam. *Seeds* rather pale brown but possibly not seen fully mature, *c.* 0.7 mm long, *c.* 0.3 mm wide, *c.* 0.4 mm thick. (Figure 1A–C)

Other specimens examined. WESTERN AUSTRALIA: SE of Corrigin, 7 Apr. 1977, *A.S. George* 14431 (PERTH); W of Jitarning, 13 Jan. 1978, *R.J. Hnatiuk* 780067 (PERTH); E of Toolibin, 1 Jan. 1988, *P. Hussey s.n.* (PERTH).

Distribution and habitat. Extends from near Toolibin north-east to about half way between Corrigin and Kulin (Figure 2). Occurs in sandy soils, recorded at one site over laterite in closed heath, at another site with lateritic gravel and at a third on sand with low kwongan.

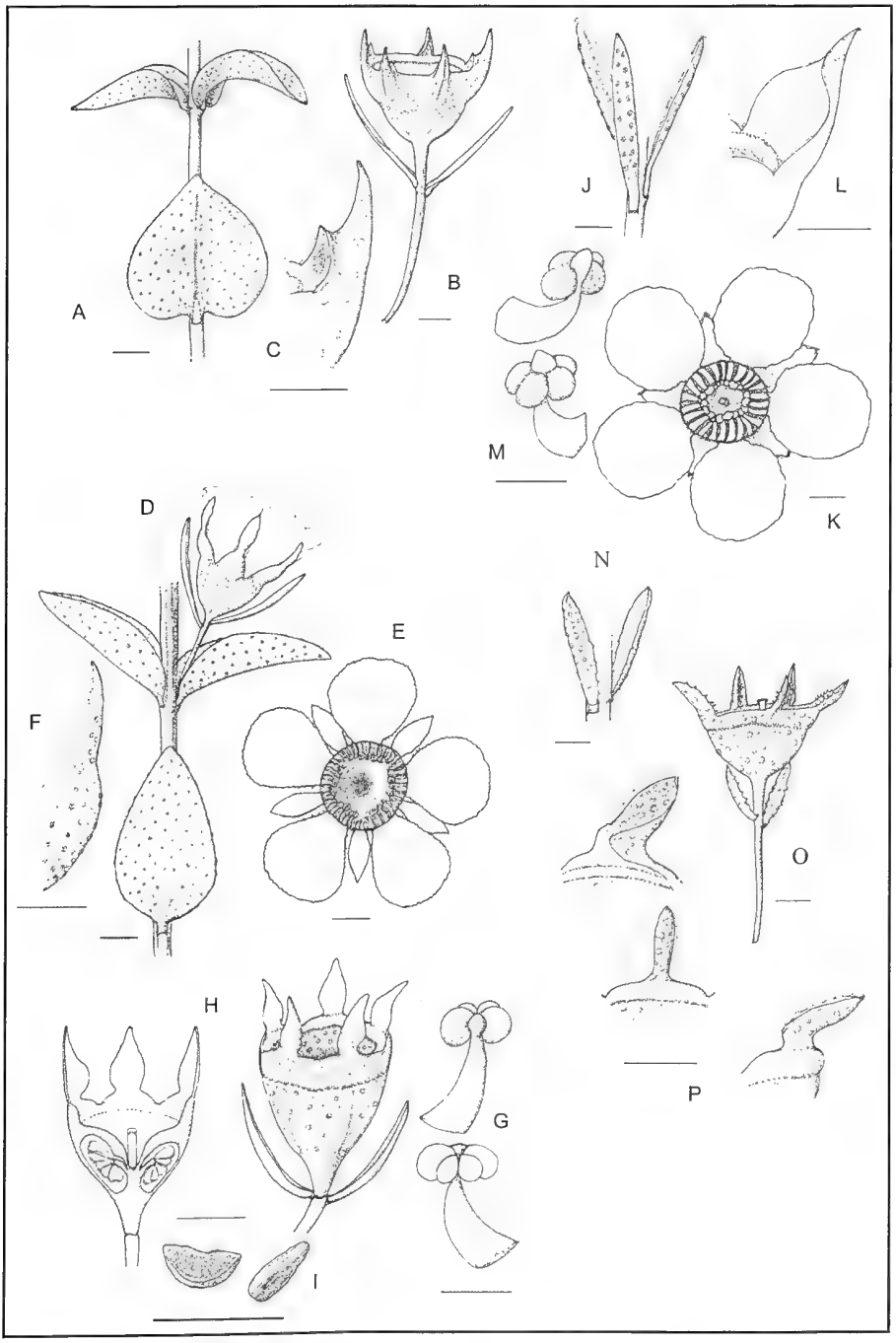

Figure 1. A–C. *Oxymyrrhine cordata*. A – leaves, B – bracteoles and young fruit, C – sepal from side view to show horn; D–I. *O. coronata*. D – leaves, bracteoles and side view of flower, E – top view of flower, F – side view of sepal, G – two views of stamen before dehiscence, H – fruit and LS of fruit, I – two views of seed; J–M. *O. gracilis*. J – leaves, K – top view of flower, L – oblique view of sepal, M – two views of stamen before dehiscence; N–P. *O. plicata*. N – leaves, O – bracteoles and fruit, P – three views of sepal. Drawn by Lorraine Cobb from *P. Rose & G. Warren* 172 (A–C), *R.J. Cranfield* 1983 (D–F), *F. Hort* 2233 (G,H), *B.L. Rye* 231229 (J–M), *K.R. Newbey* 10905 (N–P).

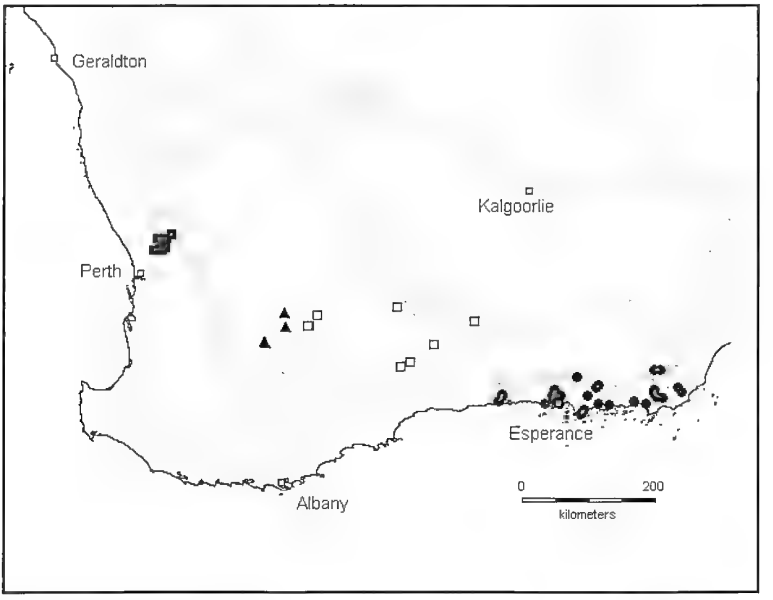

Figure 2. Distribution of *Oxymyrrhine s. str.* species: *O. cordata* (▲), *O. coronata* (■), *O. gracilis* (●) and *O. plicata* (□).

Phenology. Flowers mainly December to January. Mature seeds were collected in early April.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. There are currently only four collections of this taxon, two possibly from the same location, the known range *c.* 60 km long. At least one of the known localities has been cleared (Alex George pers. comm.).

Etymology. From the Latin *cordatus* (heart-shaped), referring to the heart-shaped leaves.

Affinities. This species is a very distinctive taxon, distinguished from other members of the genus by its cordate leaves and prominently horned sepals. It appears to be closer to *Oxymyrrhine coronata* and *O. plicata* than to *O. gracilis*.

2. Oxymyrrhine coronata Rye & Trudgen, *sp. nov.*

Species exigua constrictione versus basim sepalorum a congeneribus diversa, a *Oxymyrrhine cordata* sepalis incornutis, a *O. gracili* foliis anguste obovatis vel ellipticis, et a *O. plicata* stylo breviore differt.

Typus: Chittering Valley, Western Australia, 10 December 1981, *R.J. Cranfield* 1983 (*holo:* PERTH 03259951; *iso:* CANB, K, MEL).

Baeckea sp. A, in N.G. Marchant *et al.*, *Fl. Perth Region* 1: 384 (1987).

Baeckea sp. Chittering (R.J. Cranfield 1983), in G. Paczkowska & A.R. Chapman, *West Austral. Fl.: Descr. Cat.* p. 348 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed July 2007].

Shrub 0.4–0.8 m high, with antrorse to widely spreading leaves that are often dense on the young branchlets but are distant on rapidly growing shoots. *Stipules* apparently absent. *Petioles* 0.1–0.4 mm long. *Leaf blades* usually narrowly obovate to broadly elliptic, 3.5–7 mm long, 1.5–3 mm wide, not very thick, acute, with margins toothed; abaxial surface convex, the keel thickened towards the apex into a ridge and incurved at apex where there is often a subterminal mucro up to 0.3 mm long in addition to the acute or minutely mucronate apex, with 3–6 main rows of small oil glands on each side of the midvein; adaxial surface concave, oil glands smaller than on abaxial surface and inconspicuous. *Inflorescence* of usually 2–13 pairs of flowers towards end of each branchlet. *Peduncles* 1.5–4 mm long. *Bracteoles* persistent in flower and usually to the mature fruiting stage, linear to narrowly ovate, with incurved margins (i.e. deeply concave/arched adaxially), 2.4–4 mm long, 0.3–0.6 mm wide, herbaceous, green; apex with keel incurved, sometimes with a subterminal point up to 0.3 mm long, entire. *Pedicels* almost absent or up to 0.3 mm long. *Flowers* 5.5–8 mm diam. *Hypanthium* 1.7–2.1 mm long, 2.5–2.7 mm wide, with rather large oil glands, tending to be glaucous, sometimes somewhat 5-ribbed; adnate portion green; free portion 0.5–0.6 mm long, often purplish or tinged with dark pink. *Sepals* 1.6–2 mm long, somewhat folded or with incurved margins and often appearing ovate above a slight constriction, herbaceous throughout, the margins often somewhat serrulate; folded portion 0.3–0.5 mm thick, green towards base and centre with pinkish margins outside, usually deep pink inside. *Petals* 2.3–3.2 mm long, white or appearing pale pink inside, the pink colour not uniform, sometimes deep pink outside in bud. *Androecium* of 27–34 stamens; filaments terete, thick, tapering to a central attachment to the anther, the longest ones 0.3–0.5 mm long. *Anthers* 0.25–0.35 mm wide; slits meeting at the centre of anther, very widely divergent at base; connective gland often with 2–4 circular swellings above the attachment of the anther. *Ovary* 3-locular; placentas dark with a pale stalk, becoming prominently ridged along middle, with inner surface somewhat concave in fruit; ovules 8–14 per loculus. *Style* 0.7–0.9 mm long, with basal 0.2–0.3 mm pale and immersed; stigma broad. *Fruit c.* 1.5 mm long excluding calyx and 2.7–3.7 mm long including calyx, 2.5–3 mm diam. *Seeds* medium brown, 0.65–0.75 mm long, 0.35–0.5 mm wide, 0.4–0.5 mm thick. (Figure 1D–I)

Selected specimens examined. WESTERN AUSTRALIA: Bullsbrook, 9 Sep. 2004, *E.M. Bennett* 1017 (PERTH); Julimar area, 6 Dec. 1998, *M. Hislop* 1270 (PERTH); Moondyne State Forest, 12 Dec. 2001, *F. Hort* 1675 (PERTH); Avon Valley National Park, 9 Jan. 2002, *F. Hort* 1686 (PERTH); Julimar Conservation Park, Toodyay, 28 Dec. 2005, *F. Hort* 2762 (NSW, PERTH); Bindoon Training Area and Julimar Conservation Park, Toodyay, 7 Feb. 2006, *F. Hort* 2788 (PERTH); W of Avon Valley National Park, 28 Mar. 2004, *B.L. Rye* 240302 *& F. & J. Hort* (AD, BRI, PERTH); Chittering area, 5 May 2004, *F. & B. Hort* 2233 (PERTH).

Distribution and habitat. Occurs in lateritic habitats on the Darling Range north-east of Perth, from the Bindoon Army Training Area south to Avon Valley National Park, in eucalypt woodlands usually with Jarrah and/or Marri the dominant species (Figure 2).

Phenology. Flowers mainly late October to January. Mature seeds were collected from March to May.

Conservation status. Conservation Codes for Western Australian Flora: Priority Four. This geographically restricted species occurs in a national park, a conservation park and a few nearby locations. Its known range is *c.* 30 km long (Fred Hort pers. comm.).

Etymology. From the Latin *coronatus* (crowned), as the fruit topped by the erect sepals resembles a crown.

Affinities. The unnamed species noted by Rye (1987) as being closely related to *Oxymyrrhine coronata* [as *Baeckea* sp. A] is the one described below as *O. plicata*. The two species are similar in sepal morphology and leaf shape but are readily distinguished by the leaf and stamen characters used in the key and by other differences outlined under *O. plicata*.

Notes. In the brief description of this species for *Flora of the Perth Region* it was referred to as *Baeckea* sp. A, a name later changed to *Baeckea* sp. Chittering (R.J. Cranfield 1983) to suit altered guidelines for informal names at PERTH.

Occasionally a second flower occurs on one of the peduncles, produced in the axil of one of the displaced bracteoles and tending to open later than the main flower. Two-flowered peduncles have only been observed on a few specimens (e.g. *M. Hislop* 1270) and are very rare in comparison with the number of solitary flowers on the same specimen.

Ovule number seems extremely variable in this species. The number of stamens is also surprisingly variable for such a geographically restricted species. In most specimens the stamens directly opposite the petals are distinctly longer and have a thicker filament than those opposite the sepals, but in some specimens the antisepalous stamens are as long as or even slightly longer than the antipetalous ones. The filaments may be pale green or pink. Generally, the anther cells in this species are paler, being yellowish to medium brown, than in other members of the genus but they may have a dark pink border to the cells (where the cells are adjacent to the glandular area and closest to the attachment of the filament).

3. Oxymyrrhine gracilis Schauer, *Linnaea* 17: 240 (1843). – *Babingtonia gracilis* (Schauer) F.Muell., *Fragm. Phyt. Austral.* 4: 74 (1864). – *Baeckea gracilis* (Schauer) C.A.Gardner, *Enum. Pl. Austral. Occid.* 94 (1931). *Type*: Australia [presumably from Lucky Bay, Western Australia, January 1802], *F.L. Bauer s.n.* (*holo*: *n.v.*).

Baeckea polyandra F.Muell., *Fragm. Phyt. Austral.* 4: 72 (1864). *Type*: on the coast east of Stokes Inlet, Western Australia, *G. Maxwell s.n.* (*lecto:* MEL 72912, here chosen); inland from Orleans Bay, Western Australia, *G. Maxwell s.n.* (*lectopara:* MEL 72911, 72913).

Illustration. Blackall & Grieve (1980: 79) [as *Baeckea gracilis*].

Shrub 0.2–1 m high, usually very spindly, often emergent from dense vegetation and supported by that, often multi-stemmed from the base, with antrorse to widely spreading leaves that are dense on the young branchlets but distant on rapidly growing shoots. *Stipules* present on young leaves, short, slender, brownish or reddish. *Petioles* 0.4–0.8 mm long. *Leaf blades* linear in outline, 4–9 mm long, 0.5–0.8 mm wide, 0.4–0.5 mm thick, with margins entire or denticulate, with a whitish apical point, which is recurved and 0.1–0.2 mm long; abaxial surface deeply convex and often flattened across the top, with 1–3 main rows of small oil glands on each side of the midvein; adaxial surface shallowly v-shaped in section, oil glands often as conspicuous as on abaxial surface. *Inflorescence* of usually 1–7 pairs of flowers towards end of each branchlet. *Peduncles* 0.7–4 mm long. *Bracteoles* persistent in flower and usually to the mature fruiting stage, narrowly ovate or ovate, folded into a shallow v shape or curved around hypanthium, 1.6–2.5 mm long, 0.5–0.8 mm wide, largely herbaceous or somewhat scarious, often tinged reddish, denticulate or shortly laciniate, often with an apical point up to 0.1 mm long. *Pedicels* absent or up to 0.8 mm long. *Flowers* 6–10 mm diam. *Hypanthium* 1.6–2.5 mm long, 2.3–2.5 mm wide, with rather large oil glands, sometimes distinctly 5-ribbed, green or reddish-tinged;

free portion 0.4–0.6 mm long. *Sepals* 1.3–1.6 mm long, 1.4–1.6 mm wide, keeled, ovate-triangular to almost square, usually tinged deep pink, the narrow to very broad hyaline margins laciniate or denticulate, often with a minute, recurved apical point. *Petals* 2.5–4 mm long, white or appearing pale pink inside, the pink colour not uniform, sometimes deep pink outside in bud. *Androecium* of 22–32 stamens; filaments pale, the longest ones 0.7–1 mm long. *Anthers* 0.3–0.4 mm wide, with dark brown cells contrasting with the yellowish connective gland, which is similar in size and shape to the cells prior to dehiscence; slits basally divergent, converging on either side of connective gland. *Ovary* 3-locular; placentas dark with a moderately long pale stalk (not reaching edge of ovules but reaching edge of placenta), becoming prominently ridged along middle, with inner surface somewhat concave in fruit; ovules 10–12 per loculus. *Style* 0.7–0.9 mm long, all or almost all exposed; stigma capitate. *Fruit* 1.8–2.3 mm long excluding calyx and 3–4 mm long including calyx, 2.5–3 mm diam. *Seeds* medium brown or slightly paler, 0.6–0.8 mm long, 0.35–0.4 mm wide, 0.45–0.5 mm thick. (Figure 1 J–M)

Selected specimens examined. WESTERN AUSTRALIA: Lucky Bay, 21 Jan. 1966, *A.S. George* 7467 (PERTH); Neds Corner Road, 1 km N of South Coast Highway, N of Stokes Inlet, 11 Dec. 1999, *M. Hislop* 1951 (PERTH); 16 km NW of Point Malcolm, *c.* 160 km E of Esperance, 6 Nov. 1980, *K.R. Newbey* 8059 (MEL, PERTH); Cape Arid National Park, 1 Dec. 1971, *R.D. Royce* 9936 (NSW, PERTH); high above W bank of Torradup River on Springdale Road, 9 Dec. 2003, *B.L. Rye* 231229 (PERTH); N of the lake in Lake Monjingup Reserve, 10 Dec. 2003, *B.L. Rye* 231235 (PERTH); Cape Le Grand National Park, by Thistle Cove, 3 Jan. 1983, *A. Strid* 21915 (PERTH); 2.8 km along the Wittenoom Hills Road from the Esperance–Israelite road, 12 Jan. 1976, *M.E. Trudgen* 1518 (AD, BRI, CANB, PERTH); Helms Arboretum, N of Esperance, 17 Nov. 1993, *C.D. Turley* 56/1193 (ESP, PERTH).

Distribution and habitat. Extends from Torradup River east to Cape Arid National Park (Figure 2). Occurs in a variety of shrubland types, often in very dense vegetation where it has weak spindly shoots emergent from the tops of bushy shrubs. Even in more open situations it is not a bushy species.

Phenology. Flowers mainly from late October to early January. Mature seeds were collected in late October and late November.

Conservation status. Not considered to be at risk. This commonly collected species occurs in two large national parks and a number of other reserves.

Affinities. Oxymyrrhine gracilis is a very distinctive species. It differs from the other three species described here in its anther morphology. Its anther has a very obvious gland that forms a smooth lobe of similar size and shape to each of the two thecae, resulting in a rounded triangular shape for the anther, and the thecae have obvious long slits that diverge but do not meet at the centre of the anther. The other species have a more flattened and less obvious connective gland that tends to have some rounded swellings near the attachment of the filament, the whole anther appearing more reniform in shape. In this case the slits are very widely divergent, not far from forming a straight line, and they more or less meet at the centre of the anther. The thecae are very dark-coloured in *O. gracilis* and are medium pink to fairly dark in other taxa except perhaps in *O. plicata*, which has paler anthers or the dark colour restricted to the margin.

Notes. The original collection of this species was probably made in January 1802 when the artist Ferdinand Bauer and other members of the Matthew Flinder's expedition on H.M.S. *Investigator* were

at Lucky Bay. Schauer (1943) described the hypanthium as 5-ribbed, a characteristic that was later used in the key of Blackall & Grieve (1980: 79). This would not always allow accurate identification of this species, however, as many specimens show no obvious ribbing of the hypanthium.

Mueller (1864) seemed unaware of any relationship between his new species *Baeckea polyandra* and the earlier-named *Oxymyrrhine gracilis*, which he cited later in the same paper. Presumably he had not examined type material of *O. gracilis* and simply relied on Schauer's (1843) brief description, which suggested minor differences in the peduncle length and anther shape and also incorrectly gave the flower colour as yellow.

Oxymyrrhine gracilis is a very variable species, for example in its peduncle length, bracteole and sepal morphology, but not readily divisible into infraspecific taxa. Variation in the stamens includes some specimens (e.g. *A. Strid* 21244) with the filament very narrowed at its attachment to the anther and others with the filament rather broadly attached to the anther.

4. Oxymyrrhine plicata Rye & Trudgen, *sp. nov.*

Species sepalis arcte plicatis et stylo longiore a congeneribus diversa.

Typus: south-east of Kulin, Western Australia, 12 January 1978, *R.J. Hnatiuk* 780026 (*holo:* PERTH 03351076; *iso:* MEL).

Baeckea crispiflora subsp. Kulin (R.J. Hnatiuk 780026), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 346 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed July 2007].

Shrub 0.3–0.7 m high, with antrorse to widely spreading leaves that are dense on the young branchlets. *Petioles* 0.1–0.3 mm long. *Leaf blades* narrowly to broadly obovate, 1.8–2.7 mm long, 0.6–1.5 mm wide, not very thick, laciniate margins with shallow to deep scarious divisions, often with a mucro *c.* 0.05 mm long; abaxial surface convex, the keel thickened towards the apex into a ridge and incurved at apex where there is often a subterminal mucro similar in size to the terminal mucro, dotted with 2–4 rows of oil glands on each side of the midvein; adaxial surface concave, dotted with numerous oil glands. *Inflorescence* of usually 1–5 pairs of flowers towards end of each branchlet and sometimes with extra groups of flowers lower down on the larger branchlets. *Peduncles* 2–4 mm long. *Bracteoles* persistent in flower and usually to the mature fruiting stage, narrowly obovate to elliptic, with very incurved margins (i.e. deeply concave/arched adaxially), 1.5–2 mm long, 0.3–0.8 mm wide, acute, herbaceous, green. *Pedicels* 0.5–1.3 mm long. *Hypanthium* 1.5–2 mm long, 2–2.5 mm wide, with rather large oil glands; free portion 0.4–0.5 mm long, 5-ribbed. *Sepals* 1–1.6 mm long; folded portions 0.4–0.6 mm thick, green, with very narrow margins laciniate for their entire depth. *Petals* 1.7–2.3 mm long, white. *Androecium* of 25–31 stamens; filaments terete, thick, tapering to a central attachment to the anther, the longest ones 0.7–0.8 mm long. *Anthers* (prior to dehiscence) compressed-triangular to transversely broadly subreniform, 0.25–0.35 mm wide, with very dark brown cells and slightly paler brown connective gland closely united with the cells; slits meeting at apex, basally widely divergent, short; connective gland not prominent but sometimes slightly 2-lobed, moderately large but not very obvious, somewhat shiny. *Ovary* 3-locular; placentas dark with a moderately long pale stalk (not reaching edge of ovules but reaching edge of placenta), becoming prominently ridged along middle of a depressed pyramidal base, with inner surface somewhat concave in fruit; ovules 12–15 per placenta. *Style* 1.3–1.4 mm long, with basal *c.* 0.3 mm paler and immersed. *Fruit* 1.3–1.5 mm long excluding calyx and 2.5–3 mm long including calyx, 2.3–2.5 mm diam. *Seeds* golden brown but possibly not fully mature, 0.6–0.8 mm long, *c.* 0.3 mm wide, *c.* 0.5 mm thick. (Figure 1N–P)

Other specimens examined. WESTERN AUSTRALIA: E of Hyden, 13 Jan. 1965, *J.S. Beard* 3916 (PERTH); N of Reserve 26905, 17 Dec. 1994, *N. Casson & A. O'Connor s.n.* (PERTH); near Pallarup Rocks, 14 Dec. 1960, *A.S. George* 2262 (PERTH); Dunn Rock Nature Reserve, 28 Aug. 2002, *C. Godden & G. Woodman* FR 209.5 (PERTH); Hopkins Nature Reserve, S of Kondinin, 9 Sep. 1999, *G.J. Keighery & N. Gibson* 5411 (PERTH); SE of Kulin, 12 Jan. 1978, *R.J. Hnatiuk* 780048 (PERTH); NW of Ninety Mile Tank, 21 Jan. 1985, *K.R. Newbey* 10905; Frank Hann National Park, 10 Dec. 1971, *R.D. Royce* 10224 (PERTH); N of Hyden, 12 Jan. 2004, *B.L. Rye* 250102 *& M.E. Trudgen* (AD, CANB, NSW, PERTH).

Distribution and habitat. Extends from Kulin east to Frank Hann National Park, in sandy soils, mostly on gentle slopes or flat ground, in varied vegetation types including two records with *Allocasuarina* (Figure 2).

Phenology. Flowers recorded from December to January. Mature seeds were collected in January.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Known from ten collections, including a national park and two nature reserves, this taxon occurs in an area extending *c.* 200 km.

Etymology. From the Latin *plicatus* (folded), in reference to the sepals.

Affinities. In *Flora of the Perth Region* (Rye 1987: 384), it was noted that the Darling Range species *Oxymyrrhine coronatum* [as *Baeckea* sp. A] was closely related to an unspecified inland species; the latter species is described here as *O. plicata.* See notes under *O. coronata.*

Notes. The hypanthium in *Oxymyrrhine plicata* is usually somewhat 5-ribbed for its full length at anthesis, with the free portion always fairly strongly ribbed and remaining so in fruit but the adnate portion tending to become smooth in fruit.

Acknowledgements

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Three new species of *Tecticornia* (Chenopodiaceae, subfamily Salicornioideae) identified through Salinity Action Plan surveys of the wheatbelt region, Western Australia

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Abstract

Shepherd K.A. & Lyons, M.N. Three new species of *Tecticornia* (Chenopodiaceae, subfamily Salicornioideae) identified through Salinity Action Plan surveys of the wheatbelt region, Western Australia. *Nuytsia* 19(1): 167–180 (2009). A number of potentially new species have been discovered through ongoing Government surveys of the wheatbelt region of Western Australia. Three new samphires identified from collections made in saline areas during these surveys are described here: *Tecticornia annelida* K.A.Sheph. & M.Lyons, *T. sparagosa* K.A.Sheph. & M.Lyons and *T. loriae* K.A.Sheph. & M.Lyons. Distribution maps and illustrations of these new species are included.

Introduction

A major biological survey of the Wheatbelt region of Western Australia was conducted from 1997 to 2001 as part of the Western Australian Government's Salinity Action Plan (SAP). The survey aimed to document biodiversity values and patterning across the region to inform conservation planning in response to the threats to biodiversity posed by dryland salinity (Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection, Water and Rivers Commission 1996; State Salinity Council 2000). While the full topographic catena of the region was sampled, emphasis was placed on low lying areas including valley floor terrestrial habitats and wetlands, as these were seen to be under greatest threat from hydrological change (Keighery *et al.* 2004). Within the wetlands component further emphasis was placed on the diverse array of naturally saline wetlands and their associated landforms that characterise the region (Lyons *et al.* 2004).

Halophytic species of the genus *Tecticornia* Hook.f., more commonly known as samphires, comprise the dominant vegetation fringing naturally saline wetlands. While the succulent, articulated stems characteristic of samphires ensure they are easily recognised as an assemblage, their modified morphology and reduced floral features provide considerable taxonomic challenges. Many find these plants difficult to identify to the species level and as a consequence, samphires are often ignored and are generally poorly collected. The systematic approach of the regional SAP survey program significantly increased the number of collections of samphires from a range of saline areas in the Wheatbelt region of Western Australia. Through this work a number of taxa were identified as potentially new,

highlighting the importance of biological surveys particularly when focused on regions where there may have previously been a lack of focus. Through ongoing taxonomic work on the genus *Tecticornia* three new taxa, discovered through these SAP surveys, are now confirmed as new species and are formally described here.

Methods

This study is based on the examination of fresh or spirit material (preserved in 70% ethanol) and herbarium specimens lodged at PERTH. Measurements were made using calipers and a microscope graticule. Where spirit material was unavailable floral and fruit characters were measured from dried herbarium sheets and from material re-hydrated in a weak solution of hot water and detergent. The terminology used to describe the structure of the bracts follows Shepherd (2007a). An Environmental Scanning Electron Microscope was used to produce images of seeds (Danilastos 1993). Distribution maps were produced using DIVA-GIS Version 5.2.0.2 and include the Interim Biogeographic Regionalisation for Australia (IBRA) categories Version 6.1 as modified on *FloraBase* (Department of the Environment, Water, Heritage and the Arts 2008). The precise locality for species known from only a few populations is obfuscated due to conservation concerns.

Taxonomy

Tecticornia annelida K.A.Sheph. & M.Lyons *sp. nov.*

Ab andromonoeciis *Tecticorniae* Hook.f. speciebus aliis omnibus humili habitu, floribus bisexualibus, bracteis marginibus membranaceis, seminibus 2–2.2 mm longis.

Typus: north of Mingenew, Western Australia [precise locality withheld for conservation reasons], 30 September 2000, *M.N. Lyons & S.D. Lyons* 4189 (*holo*: PERTH 07872976, *iso*: AD, CANB, DNA, MEL).

Halosarcia sp. Gunyidi (M.N. Lyons 2607); *Tecticornia* sp. Gunyidi (M.N. Lyons 2607) Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed December 2008].

Perennial decumbent or low sub-shrub 0.1–0.3 m high. *Vegetative articles* ovoid to obovoid, circular in cross section, glaucous, pale green, 4–9 mm long, 3–6 mm wide, epidermis smooth, apex truncate, margin entire, membranous, 0.3–0.5 mm wide. *Inflorescence* 12–50 mm long, 3.5–6 mm wide, forming a spike 5–11 nodes long, cylindrical with an even to sinuate outline; terminal to main or lateral branches; florets in each 3-flowered cyme bisexual. *Bracts* obovoid, fused, convex in face view with upper edge shallowly curved, concave in side view with upper edge shallowly curved, outer face of bract flat, epidermis smooth; apex truncate, margin entire, membranous, 0.45–0.7 mm wide; upper bracts free from subtending bracts or with slightly overlapping subtending bracts. *Flowers* with apex partially exposed above subtending bracts, fused to bracts above, fused to adjacent florets, contiguous with opposite florets. *Perianth* fused, adaxial and abaxial surfaces steeply ascending, laterally rounded or dorsiventrally flattened, apex truncate; lobes 2 large lateral lobes overlapping, margins entire. *Ovary* free from stem cortex, style sometimes bifid, membranous. *Fruiting spike* scarcely expanded, papery or pithy. Apical vegetative growth absent. *Fruitlets* exposed above subtending bracts, fused to bracts

above, fused to lateral fruits, contiguous with opposite fruits; fruiting perianth laterally rounded or dorsiventrally flattened, membranous-papery or pithy, enclosing and fused with the pericarp, style at fruiting stage membranous or absent. *Pericarp* firm, enclosing seed, not dehiscing in medial plane. *Seed* free from pericarp, vertical relative to stem axis, ovate with a beak, 2–2.2 mm long, transparent, green to faintly gold-brown without ornamentation. *Embryo* straight, perisperm present. (Figure 1)

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 4 Sep. 1999, *M.N. Lyons* 2610 (PERTH 05518121); 5 Sep. 1999, *M.N. Lyons* 2609 (PERTH 05518148); 28 Sep. 1999, *M.N. Lyons* 2607 (PERTH 05518105); 26 Sep. 2000, *M.N. Lyons & S.D. Lyons* 3625 (PERTH 07917678); 5 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3685 (PERTH 07877633); 10 June 2002, *K.A. Shepherd & J. Wege* KS 898 (PERTH 07904983).

Distribution and habitat. This species is only known from three populations in the Geraldton Sandplains and Yalgoo IBRA regions of the Eremaean Botanical Province (Figure 2). *Tecticornia annelida* occurs on saline flats, low dunes associated with salt pans or on lower slopes associated with braided drainage lines in moderately saline orange, brown to cream-brown sand over clay. This species may be associated with samphire flats or with low herbs and open shrubs such as *Acacia eremaea*, *Melaleuca lateriflora* subsp. *acutifolia*, *Lawrencia squamata*, *Frankenia bracteata*, *Maireana amoena*, *M. oppositifolia*, *Atriplex holocarpa*, *Rhagodia drummondii*, *Eragrostis dielsii* and *Gunniopsis quadrifida*.

Phenology. This species most likely flowers in July and August as fruits are starting to mature from September to October.

Conservation status. As *Tecticornia annelida* is relatively uncommon and currently only known from three populations it is listed as Priority One under the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora.

Etymology. When dried the inflorescence of this species appears like a segmented worm due to the upright flowers and membranous margin of the bracts being paler in colour. Segmented worms belong to the Phylum Annelida taken from the Latin *annellus* meaning 'little ring' and the epithet *annelida* alludes to this feature.

Affinity. Tecticornia annelida is a low sub-shrub that is distinct in having large, upright florets that are laterally rounded. At maturity the membranous margin of the vegetative articles and fertile bracts are obvious and the upright fruits are readily observed above the subtending bracts. The ovate, translucent seeds are also distinctive, as at 2–2.2 mm in length they are among the largest recorded in the subfamily Salicornioideae (Shepherd 2004, Shepherd *et al.* 2005). Similar seeds have only been observed in four other species that were previously included in the former genus *Sclerostegia* (*Tecticornia arbuscula* (R.Br.) K.A.Sheph. & Paul G.Wilson, *T. medullosa* (Paul G.Wilson) K.A.Sheph. & Paul G.Wilson, *T. moniliformis* (Paul G.Wilson) K.A.Sheph. & Paul G.Wilson and *T. tenuis* (Benth.) K.A.Sheph. & Paul G.Wilson) (Shepherd & Wilson 2007). *Tecticornia annelida* is readily distinguished from these species as it has bisexual florets rather than being andromonoecious, where the lateral florets are male and the central floret is bisexual in each 3-flowered cyme.

Notes. Characters originally used to segregate the mostly endemic Australian samphires now placed in *Tecticornia* Hook.f. (formerly *Halosarcia* Paul G.Wilson, *Sclerostegia* Paul G.Wilson, *Pachycornia* Hook.f. and *Tegicornia* Paul G.Wilson: see Shepherd & Wilson 2007) included the presence of a single abaxial anther and a lack of sclereids in the palisade chlorenchyma (Wilson 1980). In contrast,

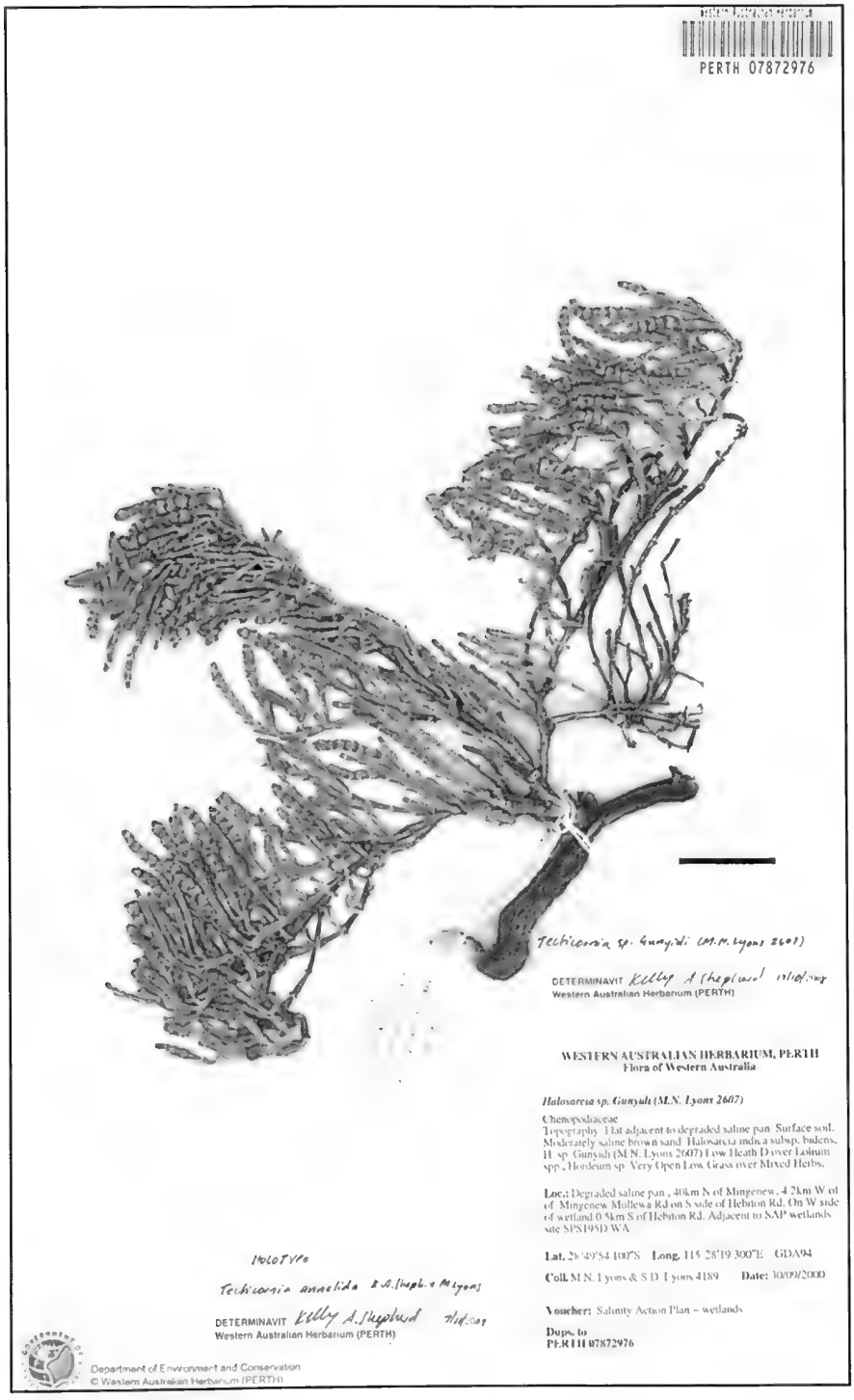

Figure 1. Holotype of *Tecticornia annelida* (*M.N. Lyons & S.D. Lyons* 4189). Scale bar = 3cm.

other common genera of the tribe Salicornioideae such as *Arthrocnemum* Moq., *Salicornia* L. and *Sarcocornia* A.J.Scott, have both an abaxial and adaxial anther in each flower and sclereids generally abundant in the palisade. These sclereids are usually spirally thickened, although some variants of *Sarcocornia quinqueflora* (Bunge ex Ung.-Sternb.) A.J.Scott have evenly thickened sclereids. More recently, Paul Wilson (pers. comm.) noted that sclereids were also present in the palisade of *Halosarcia* sp. Gunyidi (M.N. Lyons 2607), described here as *T. annelida*, which was later confirmed by Shepherd (2004). As the sclereids observed in *Halosarcia* sp. Gunyidi (M.N. Lyons 2607) are not associated with vascular tissues, nor do they form the more typical spiral formation, it was concluded that they are unlikely to be homologous to those typically found in *Arthrocnemum*, *Salicornia* and *Sarcocornia* (Shepherd 2004; Shepherd & Wilson 2007). This was supported by phylogenetic analyses of both nuclear and chloroplast DNA, as *Halosarcia* sp. Gunyidi (M.N. Lyons 2607) was shown to be more closely allied to species formerly included in the genus *Sclerostegia* than to the Australian species of *Sarcocornia* included in the study (Shepherd *et al.* 2004).

Fertile stamens are yet to be observed in *T. annelida* and it is noted that all herbarium specimens currently lodged at PERTH were collected in September and October. Since the anthers may be exserted early in the flowering season, further collections from late winter and early spring are required.

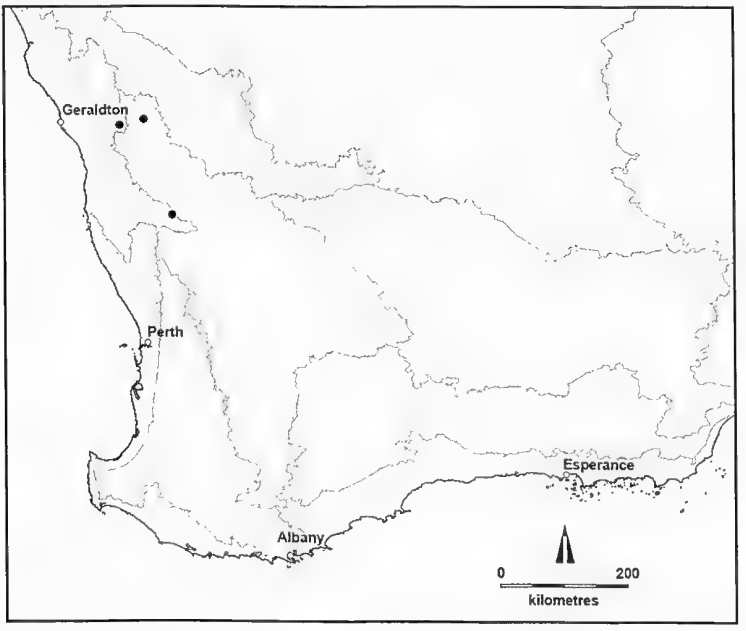

Figure 2. Distribution of *Tecticornia annelida* (•) with IBRA regions Version 6.1 in grey (Department of the Environment, Water, Heritage and the Arts 2008).

Tecticornia sparagosa K.A.Sheph. & M.Lyons *sp. nov.*

Ab *Tecticorniae indefessae* K.A. Sheph. fructibus verticalis, apicibus complanatis et acutis, basibus distentis; seminibus laevibus, 1–1.1 mm longis distinguitur.

Typus: Crown Land Reserve, *c.* 950 m north of Kendall Road on Norwood Road, east of Scaddan, Western Australia, 8 October 2007, *J.A. Wege & R. Butcher* JAW 1418 *(holo*: PERTH 07855060; *iso*: AD, CANB, MEL).

Halosarcia sp. Central wheatbelt (M.N. & S.D. Lyons 2760); *Tecticornia* sp. Central wheatbelt (M.N. & S.D. Lyons 2760), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed December 2008].

Perennial decumbent sub-shrub to 0.1 m high. *Vegetative articles* ovoid to obovoid, circular to ovate in cross section, pale green, flushed pink or red, sometimes glaucous, 2.5–7 mm long, 1.5–4 mm wide, epidermis smooth, dull, apex acute, margin entire or serrulate. *Inflorescence* 8–15 mm long, 3–4.5 mm wide, forming a spike 3–6 nodes long, cylindrical, with an even to sinuate outline; terminal to main or lateral branches; florets in each 3-flowered cyme bisexual. *Bracts* ovoid to obovoid, fused, convex in face view with upper edge curved to strongly curved, concave in side view with upper edge curved, outer face of bract flat, epidermis smooth, dull; apex acute, margin entire to serrulate; with overlapping subtending bracts. *Flowers* covered by subtending bracts or with the apex rarely exposed, free from bracts above and below, fused to adjacent florets, contiguous with opposite florets. *Perianth* fused, adaxial and abaxial surfaces steeply ascending, laterally dorsiventrally flattened, apex acute; lobes 2 lateral lobes overlapping, margins entire. *Ovary* free from stem cortex, style bifid, membranous. *Fruiting spike* scarcely expanded, papery or pithy. Apical vegetative growth absent. *Fruitlets* covered by subtending bracts, free from bracts above and below, fused to lateral fruits, contiguous with opposite fruits; fruiting perianth apex dorsiventrally flattened rounded towards the base, spongy to crustaceous, finely areolate, enclosing and fused with the pericarp, style at fruiting stage absent. *Pericarp* firm, enclosing seed, not dehiscing in medial plane. *Seed* free from pericarp, vertical relative to stem axis, ovate with a beak, 1–1.1 mm long, opaque, light gold-brown without ornamentation. *Embryo* straight to slightly curved, lateral perisperm present. (Figure 3)

Specimens examined. WESTERN AUSTRALIA: Lakelands Nature Reserve, 18 Nov. 1998, *E. Bennett & A. Paton* L 2.2 (PERTH 05358256); Truslove, 6 Nov. 1978, *R.J. Cranfield* 1047 (PERTH 02493527); W end, One Mile Rocks Reserve, 12 Nov. 1970, *A.S. George* 10503 (PERTH 02667584); Mortlock River East flats, 100 m W of N extension of Mussard Road, 1.4 km N of Great Eastern Highway, 5.5 km NW of Cunderdin, Jaspers Property, Salinity Action Plan wetlands site SPS207D, 12 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3668 (PERTH 07877528); 24 km NE of Kulin within Kondinin Salt Marsh NR C26692, 0.3 km N of track, 4.35 km W of Fotheringhame Road along southern boundary track, adjacent to Salinity Action Plan wetlands site SPS017G, 16 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3675 (PERTH 07877412); Reserve C27684, 16 km SE of Pingaring, 5.3 km from Burngup Road North on N side of Kent Road, Salinity Action Plan wetlands site SPS213B, 17 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3676 (PERTH 07877404); Lake Chinocup saline flats within Chinocup Nature Reserve A28395, 50 m W of Chinocup Road 3 km S of Tees Road, *c.* 12 km WNW of Pingrup townsite, Salinity Action Plan wetlands site SPS210C, 18 Oct. 2000, *M.N. Lyons & S.D. Lyons* 3677 (PERTH 07877420); N side of Rasmussen Road, 4.1 km E of North Chinocup Road, Chinocup Nature Reserve A28395, *c.* 16 km NNW of Pingrup townsite, 20 Dec. 2002, *M.N. & S.D. Lyons* 2760 (PERTH 06614884); 21 km E of Scaddan on Styles Road, 10 Sep. 1984, *P. van der Moezel* PGV 455 (PERTH 02668599); 9 km E of Scaddan on Norwoods Road, 27 Mar. 1985, *P. van der Moezel* PGV 466 (PERTH 02668580); 600 m W of Rasmussen Road from Gray Road intersection, NNW of Pingrup, 29 Nov. 2007, *K.A. Shepherd & S.R. Willis* KS 1069 A (PERTH 07904967).

Distribution and habitat. *Tecticornia sparagosa* is found in the Avon Wheatbelt and Mallee IBRA regions of the Southwest Botanical Province (Figure 4). This species is found around the flat floodways or gentle slopes along the margins of salt lakes or beside channels within broad braided saline flats, in white or cream-brown saline or gypseous loam and sand associated with samphire mosaics or low shrubs and herblands including *Atriplex hymenotheca*, *Roycea pycnophylloides*, *Calandrinia granulifera*, *Gnephosis tridens* and *Centrolepis eremica.*

Figure 3. *Tecticornia sparagosa*. A – Mike Lyons taking a habit photograph, with more plants in the foreground; B & C – habit; D – subtending bracts completely cover the flowers in each inflorescence, in the left inflorescence creamy-yellow stigmas are exserted; E – left inflorescence shows the apex of flowers just apparent above the subtending bract (*M.N. Lyons & C. McCormick* 4890).

Phenology. Flowering specimens have been observed in September and October.

Conservation status. This species is known from a range of salt lakes in the wheatbelt region of south-west Western Australia and is not currently under threat.

Etymology. The epithet is derived from the Greek word *sparagosis* meaning 'distention' or 'swelling' in reference to the distinct shape of the mature fruit which is dorsiventrally flattened towards the apex and then bulges sharply outwards towards the base where the upright seed is enclosed.

Affinity. *Tecticornia sparagosa* has a low decumbent habit and it may be mistaken for the mat-like *T. indefessa* K.A.Sheph., particularly where they grow in the same vicinity north of Esperance. The distinct fruits of *T. sparagosa* readily distinguish it however, as the adaxial and abaxial surfaces of the mature perianth are steeply ascending, the apex is acute and dorsiventrally flattened while the base is distended outwards. In contrast, *T. indefessa* has broadly obovate fruits with a truncate apex (Shepherd 2007b) and glossy rather than dull articles that are more typical of *T. sparagosa*. While *T. annelida* has a similar decumbent habit, it is recognised as distinct from *T. sparagosa* by its fruiting perianth which is not distended at the base and its seeds, which are twice the size.

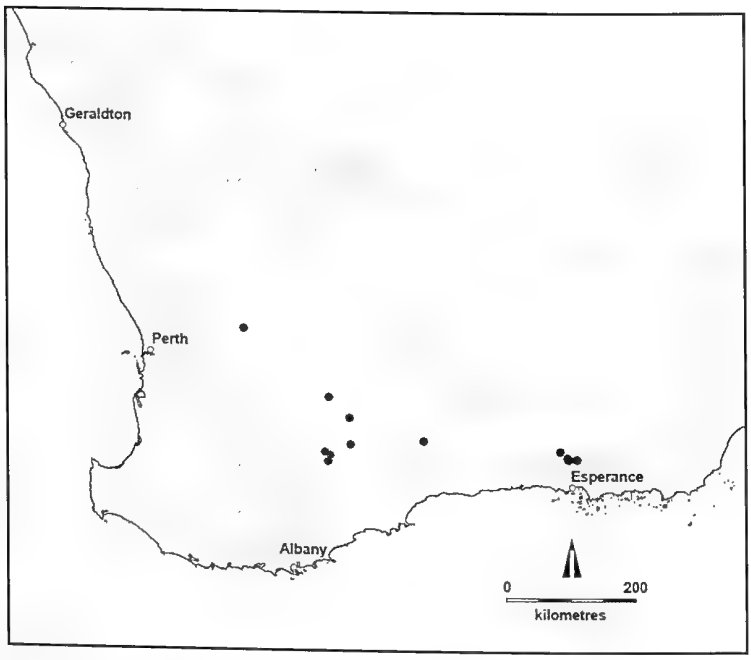

Figure 4. Distribution of *Tecticornia sparagosa* (•) with IBRA regions Version 6.1 in grey (Department of the Environment, Water, Heritage and the Arts 2008).

Notes. Fertile stamens have not been observed in *T. sparagosa* and all current specimens lodged at PERTH were collected late in the year from October to December. Thus, as for *T. annelida*, further collections obtained in early spring are required.

Tecticornia loriae K.A.Sheph. & M.Lyons *sp. nov.*

Tecticorniae halocnemoidi subsp. *catenulatae* (Paul G.Wilson) K.A.Sheph. & Paul G.Wilson similis, sed articulis glaucis, cylindricis, seminibus rotundatis, margine externo papillis digitiformibus, cellulis lateralibus undulatis differt.

Typus: east side of Lake Moore, lake bed north of embayment of lake, 13 km north-north-west of Remlap Homestead, Site SPS 148F, Western Australia, 31 August 1999, *M.N. Lyons* 2603 (*holo*: PERTH 05501369, *iso*: AD, CANB, MEL).

Halosarcia sp. Lake Moore (M.N. Lyons 2603); *Tecticornia* sp. Lake Moore (M.N. Lyons 2603), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed December 2008].

Perennial shrub to 0.2–0.5 m high, 0.1–0.3 m wide. *Vegetative articles* narrowly cylindrical, circular in cross section, pale green or pink, glaucous, 2.2–10.5 mm long, 1–2.5 mm wide, epidermis smooth, dull, apex truncate to acute, margin entire. *Inflorescence* 4–19 mm long, 1.3–2.2 mm wide, forming a spike 3–9 nodes long, cylindrical, with a sinuate outline; terminal to main or lateral branches, rarely with continued vegetative growth; florets in each 3-flowered cyme bisexual. *Bracts* cylindrical to narrowly obovoid, fused, cylindrical or convex in face view with upper edge straight to shallowly curved, cylindrical or concave in side view with upper edge straight or shallowly curved, outer face of bract flat or slightly rounded, epidermis smooth, dull; apex truncate, margin entire; upper bracts

free from subtending bracts or with slightly overlapping subtending bracts. *Flowers* completely or partially exposed above subtending bracts; free from bracts above and below, free from adjacent florets, contiguous with opposite florets. *Perianth* fused, adaxial surface horizontal, abaxial surfaces horizontal to ascending, laterally square, apex truncate; lobes 3, with a small, rounded abaxial lobe inside or outside two lateral lobes, margins entire. *Stamen* 1, oblong anther 0.5–0.7 mm long abaxial to ovary. *Ovary* free from stem cortex, style bifid, membranous. *Fruiting spike* scarcely expanded, papery. Apical vegetative growth absent or rarely present. *Fruitlets* exposed and extending beyond subtending bracts, free from bracts above and below, free from lateral fruits, contiguous with opposite fruits; fruiting perianth laterally square, apex truncate, papery, fused with the pericarp, style at fruiting stage absent or membranous. *Pericarp* not enclosing seed, not dehiscing in medial plane. *Seed* free from the pericarp, vertical relative to stem axis, ovate with a beak, 0.6–0.9 mm long, opaque, light brown with rows of well spaced, finger-like, short, papillae on the outer margin and towards the centre of the seed. *Embryo* straight to slightly curved, lateral perisperm present. (Figures 5–7)

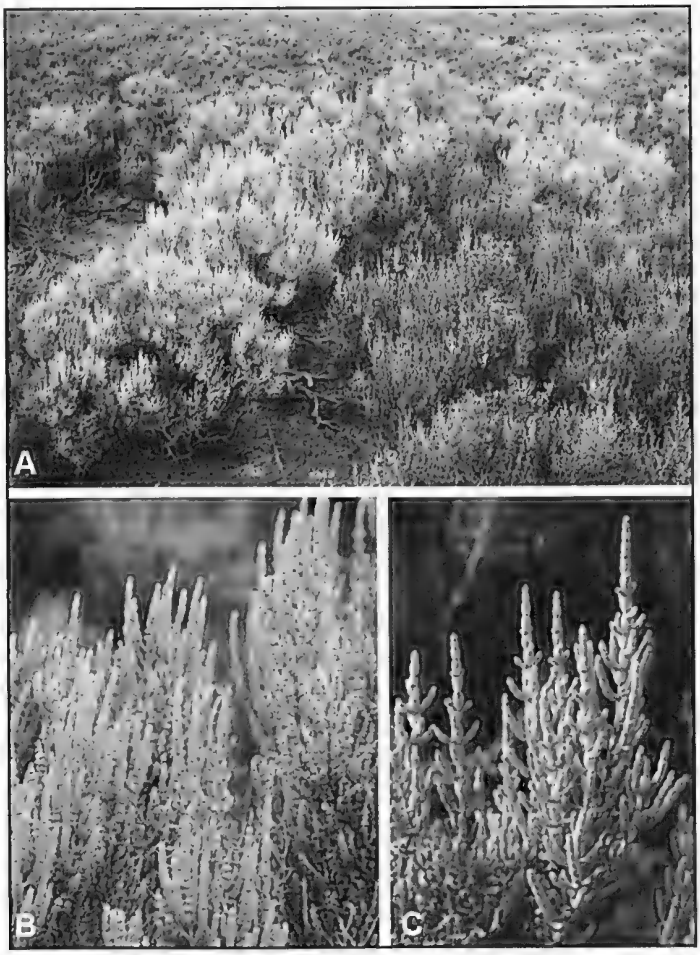

Figure 5. *Tecticornia loriae*. A – habit; B – branchlets with rectangular, pale pink articles and pale brown fruiting inflorescences (*K.A. Shepherd* KS 901); C – southern populations with pale green, rectangular articles and many secondary branchlets (*K.A. Shepherd* KS 1180).

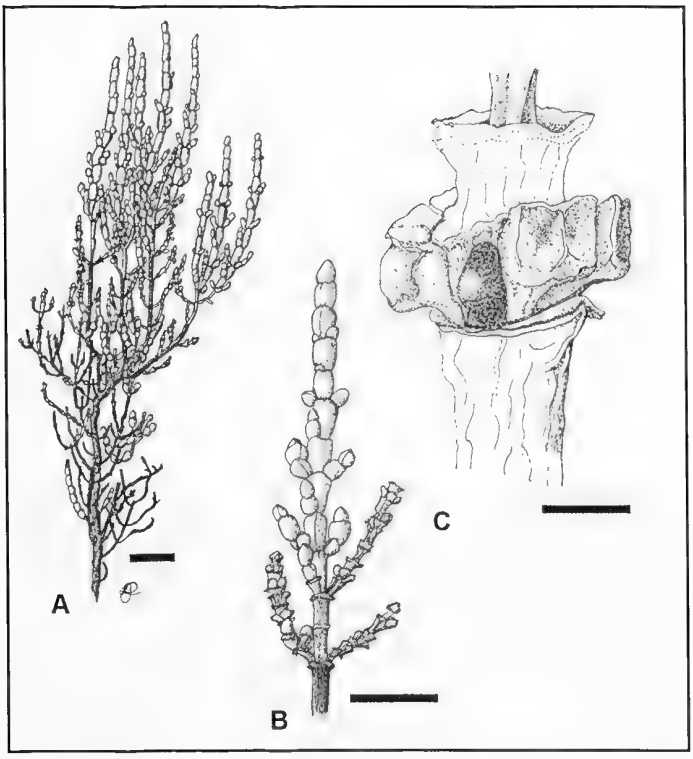

Figure 6. *Tecticornia loriae*. A – habit; B – branchlet bearing three inflorescences; C – a triad of laterally square fruits, with the left fruit removed to expose a seed (*K.A. Shepherd* KS 901). Scale bars = 10 mm (A & B), 1 mm (C).

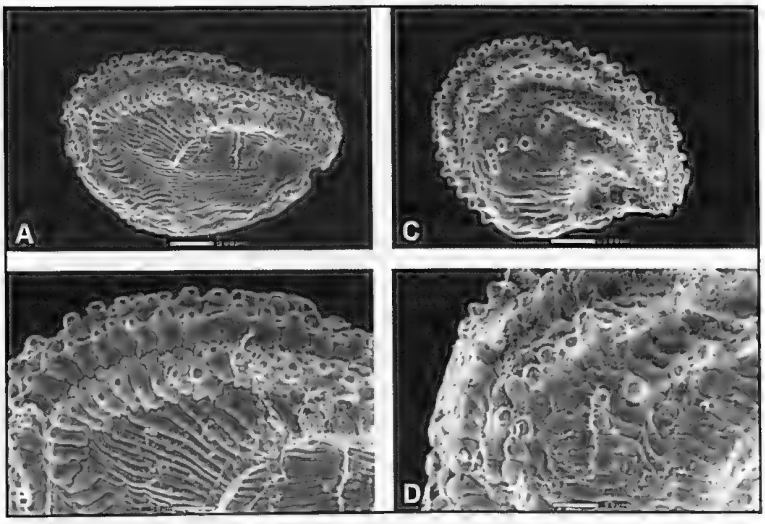

Figure 7. A & B – seeds of *Tecticornia halocnemoides* subsp. *catenulata* ; C & D – seeds of *T. loriae*. A & B – *P.G. Wilson* 8585, C – *K.A. Shepherd* KS 764; D – *B.G. Muir* 550. White scale bars = 100 µm (A & C), 50 µm (B & D).

Specimens examined. WESTERN AUSTRALIA: Linear Lake in NE, Reserve No. 26687, 13 Jan. 1995, *N. Casson & A. O'Connor* G 476.4 (PERTH 04230329); SW corner of Lake Wallambin (Reserve 21719), 21 Jan. 1995, *N. Casson & A. Harris* G 490.4 (PERTH 04230310); Lochada Station, 14 May 2002, *A. Chant & C. Forward* 1 (PERTH 06280838); on S side of Winchcombe Road, 5.4 km W of Dempster Rock Road, Lake Gulson Nature Reserve, *c.* 62 km SE of Hyden. Plot - HY02, 26 Sep. 1997, *G.J. Keighery & N. Gibson* 7092 (PERTH 06604277); on E side of English Rd, *c.* 2.5 km S of Chandler–Nungarin Rd, Lake Campion Nature Reserve, *c.* 31 km NE of Nungarin, Plot - MN09, 30 Sep. 1997, *G.J. Keighery & N. Gibson* 4175 (PERTH 07624786); Lake Harvey, 14 km N of Mollerin, centre of lake towards S end, Site SPS 143B, 14 Aug. 1999, *M.N. Lyons* 2604 (PERTH 05501385); saline pan immediately N of the Wannara [Wanarra] Road, 1.3 km E of the Mongers Lake crossing, 19 Aug. 1999, *M.N. Lyons* 2605 (PERTH 05501377); Lake Varley, 55km NE of Newdegate within Lake Varley Nature Reserve A27928, 4.5 km SW of Holt Rock town site, on SE edge of Lake Varley. SAP wetlands site SPS019C, 15 Sep. 1998, *M.N. Lyons & S.D. Lyons* 3447 (PERTH 07836074); Lake King, 8.8km W of Lake King Road on N side of Newdegate-Ravensthorpe Road within Lake King Nature Reserve A39422, SAP wetlands site SPS071B, 17 Sep. 1998, *M.N. Lyons & S.D. Lyons* 3446 (PERTH 07836058); Cowcowing Lakes, 0.7 km north of Nalkain Road on Wyalkatchem North Road, 28 Sep. 1999, *K.A. Shepherd & J. English* KS 479 (PERTH 07992270); 34.5 km N of Wubin on Great Northern Highway, near park area, 11 June 2002, *K.A. Shepherd & J. Wege* KS 901 (PERTH 07904940); 23 km NE of Scaddan on Styles Road, 27 May 1982, *P. van der Moezel* PGV 55 (PERTH 02478412); southern end of Lake Camm, 16 km NW of Lake King township, 15 Aug. 1968, *P.G. Wilson* 7144 (PERTH 02479524); southern margin of Lake Barlee, 25 Aug. 1970, *P.G. .Wilson* 8814 (PERTH 01932977; CANB); E bank of Lake King near causeway, 29 Sep. 1970, *P.G. Wilson* 9991 (PERTH 02669005).

Distribution and habitat. A widespread species occurring in the Yalgoo, Murchison and Coolgardie IBRA regions of the Eremaean Botanical Province and the Avon Wheatbelt and Mallee IBRA regions of the Southwest Botanical Province (Figure 8). *Tecticornia loriae* is found on flat floodways, sometimes in damper areas more toward the centre of salt lakes rather than the drier outer margins, in gypseous and saline light brown to red clayey sand with *Tecticornia* spp. and low open herbs and shrubs including *Atriplex holocarpa, Eremophila miniata* and *Chondropyxis halophila.*

Phenology. Flowers have been recorded from August to September and fruits begin to form in late September and October.

Conservation status. This species is known from a number of populations and is not considered to be under threat.

Etymology. Tecticornia loriae is named in honour of Lorraine (Lori) Cobb (1951–2008) a dear friend who was a talented and passionate botanist and gifted botanical artist (Shepherd & Butcher 2008). The illustration of *T. loriae* included here (Figure 6) is a wonderful example of her skill and was the last one she produced for Kelly Shepherd.

Affinity. Tecticornia loriae, like the newly phrase-named *T.* sp. Dennys Crossing (K.A. Shepherd & J. English KS 552), was previously included in the morphologically variable *T. halocnemoides* (Nees) K.A.Sheph. & Paul G.Wilson. Currently there are five subspecies recognised within *T. halocnemoides* but it is likely that many other taxa will be recognised as distinct with further taxonomic work. *Tecticornia loriae* is most closely allied to *T. halocnemoides* subsp. *catenulata* (Paul G.Wilson) K.A.Sheph. & Paul G.Wilson within this complex. When Wilson (1980) first described this subspecies he noted there was a glaucous form with collections from Mollerin Lake, Lake Barlee, north of Norseman and

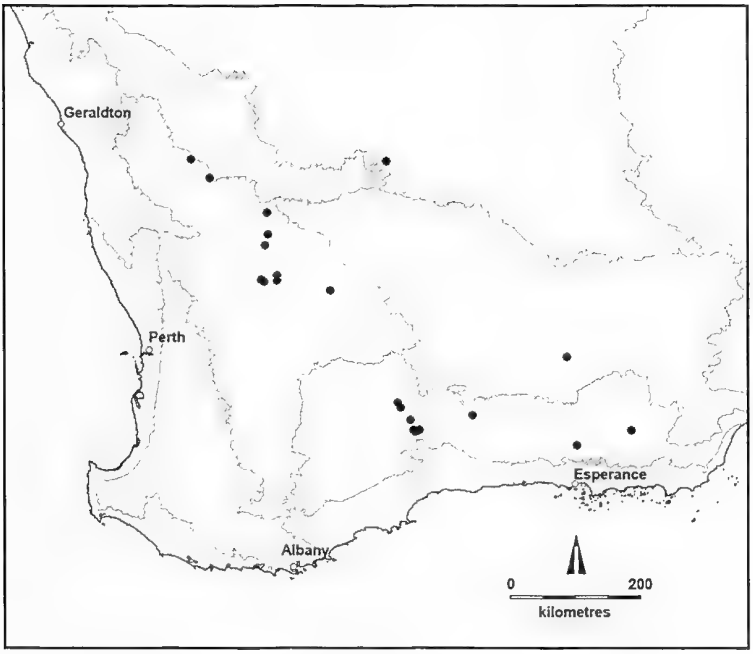

Figure 8. Distribution of *Tecticornia loriae* (•) with IBRA regions Version 6.1 in grey (Department of the Environment, Water, Heritage and the Arts 2008).

Lake King (PERTH 02478323; PERTH 01932977; PERTH 02478455; PERTH 02478439; PERTH 02478382; PERTH 02478447). Wilson commented that these glaucous articles were unique to this variant within the *T. halocnemoides* complex, as in all other variants the articles were either glossy or dull. Wilson (1980) noted that the flowers and seeds of the typical *T. halocnemoides* subsp. *catenulata* and the glaucous variant were similar and therefore it did not warrant recognition as a separate entity based on the collections available at the time. On further examination of more recent material it is apparent that the seeds of *T. loriae* are smaller and more rounded compared to the more ovate seeds of *T. halocnemoides* subsp. *catenulata* (Shepherd 2004; Shepherd et al. 2005). In both taxa the seed ornamentation includes rows of finger-like papillae on the outer margin. In *T. halocnemoides* subsp. *catenulata* there are generally only two rows of papillae. Within each row the individual papillae terminate approximately halfway around the circumference of the seed. Moreover, the flat, lateral cells on the side of each seed are long and straight. In contrast, the seeds of *T. loriae* possess at least three rows of papillae on each side, with the centremost row on the lateral face becoming irregular. The papillae on the outer rows continue around the entire circumference of the seed and the flat, lateral cells on the side of each seed are shorter and more undulate (Figure 7). Furthermore, based on nuclear DNA sequence data *T. loriae* (as *T.* sp. Lake Moore KS 719) is supported as genetically distinct from *T. halocnemoides* (Shepherd *et al.* 2004).

Tecticornia loriae looks somewhat like *T. lylei* in having narrowly cylindrical articles and laterally square fruits with a truncate apex. *T. lylei* is readily distinguished by its distinctive fruits where the base of the stigma becomes hardened and the front face of the fruit inflates outwards, appearing rounded and mammilate, while the darker articles compressed against the stem resemble *Allocasuarina* cladodes. In contrast, the fruiting inflorescence of *T. loriae* is light brown and papery and the style is either absent or membranous (Figure 5B).

Notes. Like many samphires, *Tecticornia loriae* exhibits a degree of variation across its distribution and plants may range from pale pink to blue-green in colour. Towards the northern end of its range and particularly at the type population at Lake Moore, the vegetative branches of *T. loriae* are long and slender (Figure 5B) while in other populations, for example near Lake King, the vegetative branches are shorter and numerous secondary branchlets are evident (Figure 5C). However, as all these variants have the typical glaucous, rectangular articles and the fruits and seeds are also generally consistent, it does not seem appropriate to recognise this variation at the intraspecific level.

Acknowledgements

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Guichenotia anota and *Guichenotia apetala* (Lasiopetaleae: Byttneriaceae or Malvaceae *s. lat.*) a new and a revised species endemic to the Ravensthorpe Range, south-west Western Australia

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Abstract

Wilkins, C.F. & Whitlock, B.A. *Guichenotia anota* and *Guichenotia apetala* (Lasiopetaleae: Byttneriaceae or Malvaceae *s. lat.*) a new and a revised species endemic to the Ravensthorpe Range, south-west Western Australia. *Nuytsia* 19(1): 181–190 (2009). *Guichenotia anota* C.F.Wilkins is described as new and *Guichenotia apetala* A.S.George is revised. Both are endemic to the Ravensthorpe Range in south-west Western Australia. Cladistic analyses of morphological characters, and chloroplast and nuclear DNA sequences (Wilkins & Whitlock in prep.) show these two species to be most closely related to each other, and more closely related to *Lasiopetalum* Sm. than to *Guichenotia* J.Gay. As both are priority species for conservation, in an area with developmental pressures from mining, they require urgent description and revision, and are included here in the latter genus until their generic placement is certain. Anatomical leaf data is presented.

Introduction

Guichenotia apetala A.S.George and *G.anota* C.F.Wilkins, described herein as new, are restricted to Mt Short and Mt Desmond respectively within the Ravensthorpe Range, south-western Australia. They fall within tribe Lasiopetaleae (Gay 1821) which has traditionally been placed in Sterculiaceae Vent. More recently, this tribe has been included in either the sub-family Byttnerioideae, in a greatly expanded Malvaceae *sensu* Judd and Manchester (1997; see also Alverson *et al.* 1998, 1999; Bayer *et al.* 1999; Bayer & Kubitzki 2003; APG11 2003), or included in the reinstated family Byttneriaceae J.Gay (Heywood *et al.* 2007).

Guichenotia anota is closely related to *G. apetala*, with the main difference being that the leaves are oblong rather than trilobed. *Guichenotia apetala* was described in 1968 and placed in *Guichenotia* due to its having the typically ribbed outer surface of the calyx. However, George (1968) also suggested that this species was somewhat anomalous in the genus, as it lacked stipules and petals. The 15 other species currently recognised in *Guichenotia* (Wilkins & Chappill 2003) do have petals; however, there are two more recently described species with stipules always lacking (*G. asteriskos* C.F.Wilkins, *G. basivirida* C.F.Wilkins), and two species with stipules sometimes lacking (*G. impudica* C.F.Wilkins, *G. micrantha* (Steetz) Benth.). Like other *Guichenotia*, *G. apetala* and *G. anota* have pendulous flowers

and a calyx with prominent external ribs; however, these species share a number of unique features and their exact phylogentic relationship within *Guichenotia s.str.* is unresolved. As such neither were included in a recent revision of *Guichenotia* (Wilkins & Chappill 2003). *Guichenotia apetala* and *G. anota* differ from other species in the genus in that the outer surface has one central rib and one rib on each lobe fusion line, rather than the more typical 3–5 ribs in the centre of the lobe. Further, the calyx lobes have an obtuse-rounded rather than acute apex; petals are absent; and the ovary has three rather than five cells and the stigmatic tube is wider than the style (Figure 1E), rather than being the same width throughout. Further, the apical stigmatic pore tube is rimmed rather than unrimmed as found in other Lasiopetaleae with poricidal anther dehiscence (e.g. *Guichenotia*, *Lasiopetalum*, *Thomasia* J.Gay and *Lysiosepalum* F.Muell.). In addition, the fruit is oblong-ellipsoid rather than ovoid, obovoid or ellipsoid. Cladistic analyses of morphological chatracters, and chloroplast and nuclear DNA sequences (Whitlock & Wilkins in prep.) show that *G. anota* and *G. apetala* are more closely related to *Lasiopetalum* than to *Guichenotia*. As these species are designated as Priority One for conservation (Atkins 2008), due to their restricted distributions and because of developmental pressures from mining in the region, it was considered that *G. anota* required urgent description and *G. apetala* should be revised. They are currently placed within *Guichenotia* pending a decision regarding their generic placement, following further DNA analyses.

Methods

Anatomical comparison of fresh plant material of *G. anota* (*K.A. Shepherd* KS 90) was facilitated by fixing in glutaraldehyde, embedding in GMA resin, sectioning by microtome and staining with Toluidine Blue pH 4.4 (Feder & O'Brien 1968).

Specimens from AD, BRI, CBG, MEL, NSW and PERTH were examined and morphological information was measured and recorded.

The distribution map was produced using Online Map Creation (http://www.aquarius.geomar.de/omc_intro.html) and is based on PERTH specimen data. Localities for species with a conservation listing are withheld for conservation reasons.

Results and Discussion

Anatomy. Transverse leaf sections of *G. anota* show it to be dorsiventral and hypostomatic. Below a thick cuticle the uniseriate epidermis has single cells or groups of cells that are larger than the remaining epidermal cells and stain reddish-purple in toluidine blue. These are considered to be mucilage cells, as their staining properties indicate the presence of polycarboxylic acids, such as alginic and pectic acid (Feder & O'Brien 1968). Mucilage cells and canals are reported as characteristic of Malvaceae *s. lat.* (Metcalfe & Chalk 1950). The leaf palisade layer is biseriate, less frequently triseriate and the spongy mesophyll cells are loosely packed. Solitary crystal druses are present as cell inclusions in the spongy mesophyll layer. Cluster crystals of calcium oxalate have been reported as a feature of Malvaceae *s. lat.* with solitary cells less common (Metcalfe & Chalk 1950).

There are numerous, green-filled parenchymatous cells (believed to be tannin-filled) below the main vein in the leaf rib. The rib has a tomentum of ferruginous hairs on the outer surface and tannin inclusions in the stellate hair cells possibly account for their brown colour. Tannin has been recorded as abundant in Sterculiaceae leaves (Metcalfe & Chalk 1950).

Thickened yellow reticulate venation on the adaxial leaf surface while not obvious in *Guichenotia*, is a common feature in *Lasiopetalum*, but it is usually much less prominent than seen in *G. anota* and *G. apetala*. Medial leaf transverse sections show that beneath these prominent veins are 2–5 longitudinal rows of thick-walled sclerenchymatous cells with a closed lumen that extend from the adaxial surface to the vein above the abaxial surface

Transverse stem sections of *G. anota* reveal mucilage ducts to be absent from the pith parenchyma. Observed Lasiopetaleae *Guichenotia angustifolia* Turcz., *Keraudrenia velutina* Steetz, *Lysiosepalum involucratum* (Turcz.) Druce, *Thomasia sarotes* Turcz., *T. glabripetala* S.J.Patrick and *Seringia arborescens* (W.T.Aiton) Druce have mucilage ducts as 10–40 % of pith while species of *Hannafordia* F.Muell. have mucilage ducts as 60–70% of the total pith (Wilkins 2000).

Taxonomy

Guichenotia anota C.F.Wilkins, *sp. nov.*

Guichenotiae apetalae affinis sed lamina oblonga vel anguste obovata, non late ovata et subauriculata differt.

Typus: Mount Short, near Ravensthorpe, Western Australia [precise locality witheld for conservation reasons], 24 October 2003, *C.F. Wilkins & J.A. Wege* 1838 (*holo*: PERTH 07854846; *iso*: AD, BRI, CANB, K, MEL, NSW).

Guichenotia anota ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 541 (2000).

Dwarf, erect, multistemmed, compact, grey-green, *shrub* 10–40(–100) × 20–40 cm; *young stems* tan-brown, with a tomentum of white, stellate hairs to 0.3 mm diameter, with large, dark brown centres, glabrescent with grey outer surface flaking to reveal red-brown stem with indistinct, irregular, longitudinal ridging. *Stipules* absent. *Leaves* alternate, simple; *petiole* short, 0.5–1.5 mm long; blade oblong to narrowly-obovate, 2–7(–12) × 1.5–2(–3.8) mm; abaxial surface with a prominent rib, with a tomentum of ferruginous, stellate hairs to 0.3 mm diameter, remainder with a tomentum of white, stellate hairs to 0.5 mm diameter; adaxial surface initially with dense, fine, white, stellate hairs to 0.3 mm diameter with brown centres, glabrescent with prominent, yellow, reticulate venation; margin entire, strongly recurved; apex obtuse, mainly recurved or straight. *Inflorescence* a leaf-opposed, monochasial cyme, 15–20 mm long, flowers 3–4(–8), rarely a branched cyme (flowers 5–8). Flowers 5-merous, pendulous. *Peduncle* (3.5–)6–8 mm long. *Pedicel* 1.5–4 mm long. *Peduncle and pedicel* with white, stellate hairs to 0.25 mm diameter, with brown centres, intermixed with abundant, long-stalked, red, clavate glands to 0.5 mm long. *Bracts* 1–2 at base of each pedicel (sometimes absent from terminal flower), 1–2.5 × 0.4–0.5 mm, persistent, sessile, linear-oblong, abaxially tomentose with white, stellate hairs with large, dark-brown centres, adaxially glabrous to densely white-tomentose with stellate hairs. *Epicalyx bracts* 3, free, unilateral, directly below the calyx, 2.3–4.5 × 0.4–0.5 mm, with shape and indumentum as for the inflorescence bracts. *Calyx* petaloid, 5–8 mm long, pale pink becoming medium pink, tube *c.* 3/4 of the total calyx length, with one prominent, central rib on the outer calyx lobe and a rib at the fusion of each lobe; lobes broadly-ovate, erect, 1.3–2.5 × 2.3–3.5 mm, entire; abaxial surface with medium to dense, white, stellate hairs throughout, 0.1–0.3 mm diameter, adaxial surface glabrous at the base, with contrasting darker pink venation, lobes with fine, white, simple or sessile, few-armed,

stellate hairs to 0.15 mm long, apex rounded; fruiting calyx persistent, enclosing fruit. *Petals* absent. *Staminal tube* and *staminodes* absent. *Stamens* opposite the petals; *filaments* red, glabrous, *c.* 0.2 mm long; *anthers* ventrifixed, elliptic, touching laterally to form a tube, pink becoming dark red, glabrous, 1.5–1.8 × 0.4–0.9 mm, the thecae fused dorsally and laterally with shallow indentations at fusion lines, introrsely dehiscent by elliptic pores below a truncate apex. *Pollen* white. *Ovary* superior, sessile, 0.5–0.6 × 0.5–0.6 mm; locules three, laterally fused, outer surface with a tomentum of sessile, soft, white, stellate hairs to 0.2 mm long, inner surface glabrous or with a single hair. *Placentation* axile. *Ovules* two per locule, erect, sub-basal. *Style* single, terete with apical 1/3 slightly wider than basal 2/3, with few, white, sessile, stellate hairs at base, remainder glabrous, 3–3.5 mm long. *Stigma* a dry tube with an apical, rimmed stigmatic pore. *Fruit* a sessile, chartaceous, oblong to ellipsoid loculicidal capsule 3.5–4 × 2.5–2.8 mm; outer surface with scattered, stellate hairs. *Seed* one per locule, ellipsoid, *c.* 2 × 1 mm, outer surface dark brown, smooth, with medium dense, sessile, fine, white, stellate hairs. *Aril* cap-like with short lobes (seed voucher *K.A. Shepherd* 126, Wilkins & Chappill 2002a). (Figures 1A–F, 2A & 2B)

Chromosome number. n = 10 (*C.F.Wilkins* 1172, Wilkins & Chappill 2002b).

Flowering period. September to April.

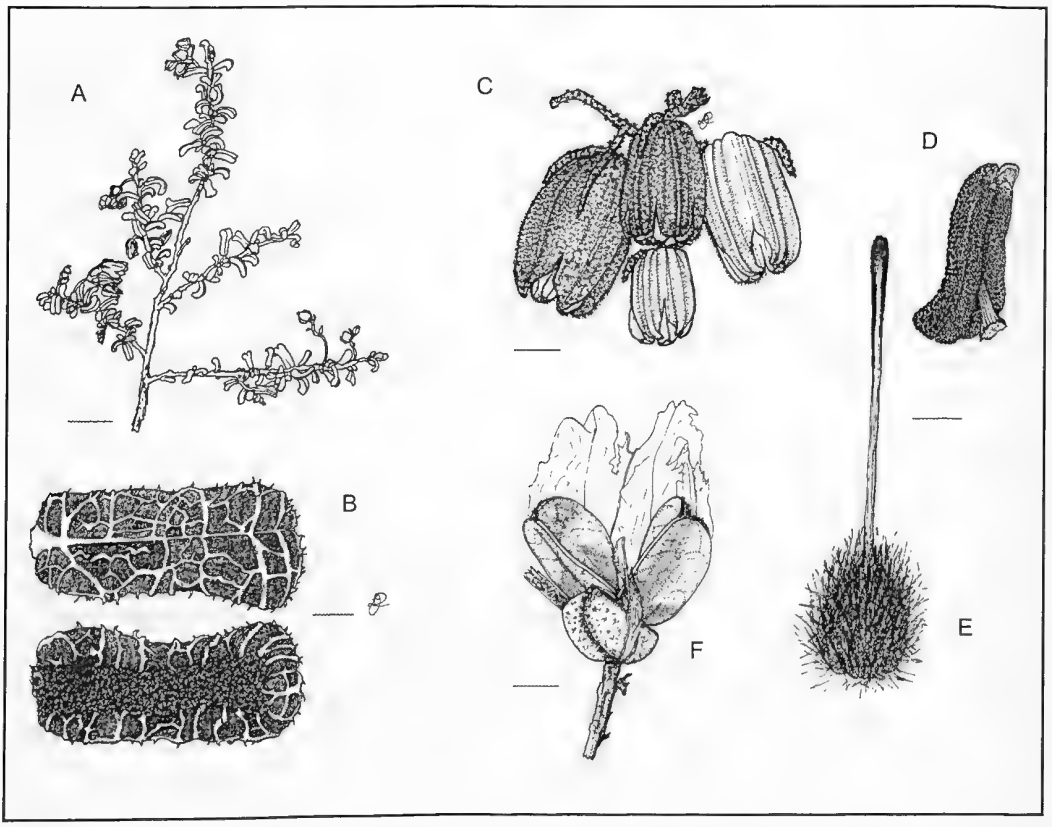

Figure 1. *Guichenotia anota* C.F.Wilkins. A – habit; B – leaf adaxial (above) and abaxial (below) surfaces; C – inflorescence of pendulous flowers; D – anther with poricidal dehiscence; E – ovary and style with stigma broader than style; F – fruit a loculicidal capsule with calyx remains. From *C.F. Wilkins* 1122. Scale bars A & B = 1 cm; C = 0.25 cm; D & E. = 0.05cm; F = 0.1 cm.

Figure 2. *Guichenotia anota* C.F.Wilkins. A – habit; B – flowering branchlet. (*C. Wilkins* 1838). Photographs by J.A. Wege.

Selected specimens. WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] 16 Nov. 2004, *S. Barrett* 1281 (PERTH); 6 Apr. 2006, *S. Barrett* 1514 (PERTH); 5 Jan. 2001, *J.A. Cochrane* 3851 (PERTH); 21 Mar. 2000, *G.F. Craig* 5176 (PERTH); 24 Nov. 1985, *D.B. Foreman* 1206 (AD, CANB, NSW, PERTH); *s.dat., Gardner* 14835 (PERTH 04205928); 16 Oct. 1964, *R. Hill* 1471 (AD); 11 Nov. 1986, *P.M. Olde* 1156 (NSW); 16 Dec. 1992, *C.J. Robinson* 1046 (PERTH); 10 Sep. 1994, *K.A. Shepherd, J.A. Chappill & J.A. Wege* 90 (PERTH); 17 Sep. 1995 *C.F. Wilkins, R. Orifici & J.A. Chappill* 1122 (PERTH); 13 Sep. 2000, *E. Tink* 496 (PERTH); 25 Sep. 1997, *C.F. Wilkins, J. Wege & R. Butcher* CW 1373 (PERTH); 13 Jan. 2002, *C.F., J.A. & G.C. Wilkins* 1502 (PERTH).

Distribution and *habitat*. This species is restricted to the vicinity of Mt Short near Ravensthorpe in Western Australia in red-brown clay on laterite, in open, mallee scrubland or heath, mainly on ridge tops and absent in swales, often associated with *Thomasia microphylla*.(Figure 3)

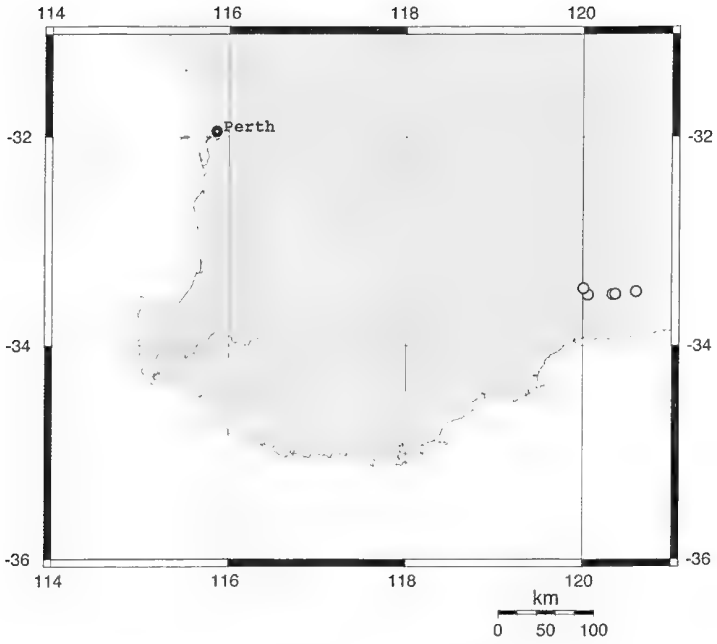

Figure 3. Distribution of *Guichenotia anota* C.F.Wilkins.

Relationships. *Guichenotia anota* is closest to *G. apetala*, differing in having leaves that are oblong with a recurved apex, rather than ovate and sub-auriculate with a straight apex, by having longer leaf petioles, longer peduncles, more glandular mature pedicels and peduncles, and a pink calyx rather than a paler pinkish-white calyx.

Etymology. The specific epithet is derived from Latin *an* (without) and *ota* (ears), referring to the oblong leaves of this species which lack the sub-auriculate lobes present on the leaf base of its closest ally *G. apetala*.

Conservation status. Due to a restricted distribution at Mt Short, *G. anota* has been allocated a conservation status of Priority One by the Department of Environment and Conservation (DEC), Western Australia (Atkins 2008).

Guichenotia apetala A.S. George. *Journal of the Royal Society of Western Australia* 50: 99 (1968).

Type citation: Mt. Desmond, SE of Ravensthorpe, 27 October 1963, *T.E.H. Aplin* 2693 (*holo*: PERTH 01037773; *iso*: CANB.)

Dwarf, erect, multistemmed, compact, grey-green *shrub*, 10–50 cm high × 10–55 cm diameter; *young stems* dark brown, with a tomentum of white, stellate hairs to 0.3 mm diameter, with large, dark brown centres, glabrescent with grey outer surface flaking to reveal red-brown stem with indistinct, irregular, longitudinal ridging. *Stipules* absent. *Leaves* alternate, simple; *petiole* short, 0.2–0.5 mm long; blade triangular-cordate, sub-auriculate, (1.5–)3.5–4.5 (–5) × (1.5–)3.5–4.5(–5) mm; abaxial surface with a prominent rib with a tomentum of ferruginous, stellate hairs to 0.4 mm diameter, remainder with a tomentum of white, stellate hairs to 0.3 mm diameter; adaxial surface initially with

medium-dense, fine, white, stellate hairs to 0.3 mm diameter with large, brown centres, glabrescent with prominent, yellow, reticulate venation; margin entire, strongly recurved; apex obtuse, straight or scarcely upturned. *Inflorescence* a leaf-opposed, monochasial cyme, 10–40 mm long, with 1–2 (–3) flowers. *Flowers* 5-merous, pendulous. *Peduncle* 1.5–4 mm long. *Pedicel* 1.5–4.5 mm long. *Peduncle and pedicel* tomentose with white, stellate hairs to 0.25 mm diameter, with brown centres, intermixed with scattered, long-stalked, red, clavate glands to 0.4 mm long, or glands absent. *Bracts* 1–2 at base of each pedicel (sometimes absent from terminal flower), 0.8–2.5 × *c.* 0.4 mm, persistent, sessile, linear-oblong, abaxially tomentose with white, stellate hairs with large, dark-brown centres, adaxially glabrous to densely white-tomentose with stellate hairs. *Epicalyx bracts* 3, free, unilateral, directly below calyx, 2–4.5 × 0.3–0.5 mm, with shape and indumentum as for inflorescence bracts. *Calyx* petaloid, 5–7 mm long, pinkish-white; tube *c.* 3/4 of total calyx length, with one prominent, central rib on the outer calyx lobe and a rib at the fusion of each lobe; lobes broadly ovate, erect, 1.3–2 × 2.3–3 mm, entire; abaxial surface with dense, white, stellate hairs throughout, 0.1–0.3 mm diameter; adaxial surface glabrous at the base, venation same colour as surface, lobes with fine, white, simple or sessile few-armed stellate hairs to 0.15 mm long, apex rounded; fruiting calyx persistent, enclosing fruit. *Petals* absent. *Staminal tube* and *staminodes* absent. *Stamens* opposite the petals; *filaments* red, glabrous, almost sessile; *anthers* ventrifixed, elliptic, touching laterally to form a tube, pink becoming dark red, glabrous, 1.5–1.8 × 0.4–0.9 mm, the thecae fused dorsally and laterally with shallow indentations at fusion lines, introrsely dehiscent by elliptic pores below a truncate apex. *Pollen* white. *Ovary* superior, sessile, 0.5–0.6 × 0.5–0.6 mm; locules three, laterally fused, outer surface with a tomentum of sessile, soft, white, stellate hairs to 0.2 mm long, inner surface glabrous or with a single hair. *Placentation* axile. *Ovules* two per locule, erect, sub-basal. *Style* single, terete with apical 1/3 slightly wider than basal 2/3, with few, white, sessile, stellate hairs at base, remainder glabrous, 3.5–4 mm long. *Stigma* a dry tube with an apical, rimmed stigmatic pore. *Fruit* a sessile, chartaceous, oblong to ellipsoid loculicidal capsule 3.5–4 × 2.5–3 mm; outer surface with scattered, stellate hairs.

Figure 4. *Guichenotia apetala* A.S.George – flowering branchlet. From *C. Wilkins* 419. Scale bar = 1 cm.

Figure 5. *Guichenotia apetala* A.S.George. A – habit; B – flowering branchlet. (*C.Wilkins* 1836). Photographs by J.A. Wege.

Seed one per locule, ellipsoid, *c.* 2 × 1 mm, outer surface dark brown, smooth, with medium-dense, sessile, fine, white, stellate hairs. *Aril* cap-like with short lobes (seed voucher *K. Newbey* 568; Wilkins & Chappill 2002a). (Figures 4, 5A & 5B)

Chromosome number. Unknown.

Flowering period. September to December.

Selected specimens. WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] 18 Sep. 1990, *D.E. Albrecht & B.A. Fuhrer* 4542 (MEL, PERTH); 21 Sep. 2005, *S. Barrett* 1420 (PERTH); 27 Sep. 1985, *M.G. Corrick* 9573 (BRI, MEL); 10 Aug. 1975, *T.C. Daniell* 1 (PERTH); 28 Sep. 2007, *C. Dornan* 227A (PERTH); 20 Oct. 1961, *C.A. Gardner* 13699 (PERTH); 14 Oct.,

A.S. George 1643 (PERTH); 30 Sep. 1999, *J.W. Horn & R. Butcher* 2692 (CANB, DUKE, PERTH); 1963, *F. Humphreys s.n.*, (PERTH); 28 Sep. 1975, *W. Green* 4517 (PERTH); 18 Oct. 1964, *R. Hill* 1477 (AD); 5 Oct. 1966, *T.B. Muir* 4223 (MEL); 21 Oct. 1962, *K. Newbey* 568 (PERTH); 11 Nov. 1986, *P.M. Olde* 1141 (NSW); 15 Dec. 1992, *C.J. Robinson* 1056 (PERTH); 18 Jan. 2002, *C.F., J.A. & G.C. Wilkins* 1510 (PERTH); 18 Nov. 1976, *E. Wittwer* W1889 (PERTH); 27 Oct. 1968, *J.W. Wrigley* 5061 (CANB, PERTH).

Distribution and habitat. This species is restricted to Mt Desmond near Ravensthorpe, Western Australia, mainly on ridges in red lateritic gravel with outcropping laterite, or brown clay over ironstone in open mallee scrubland. (Figure 6)

Relationships. Guichenotia apetala is most closely related to *G. anota* but differs in having leaves that are sub-auriculate instead of oblong-obovate, shorter sub-sessile petioles and a fewer-flowered inflorescence.

Conservation status. Due to its restricted distribution at Mt Desmond, *G. apetala* has been allocated a conservation status of Priority One by DEC, Western Australia (Atkins 2008).

Etymology. Named *apetala* for its lack of petals, a feature unique in the genus at the time of description. However, *G. anota* also has no petals.

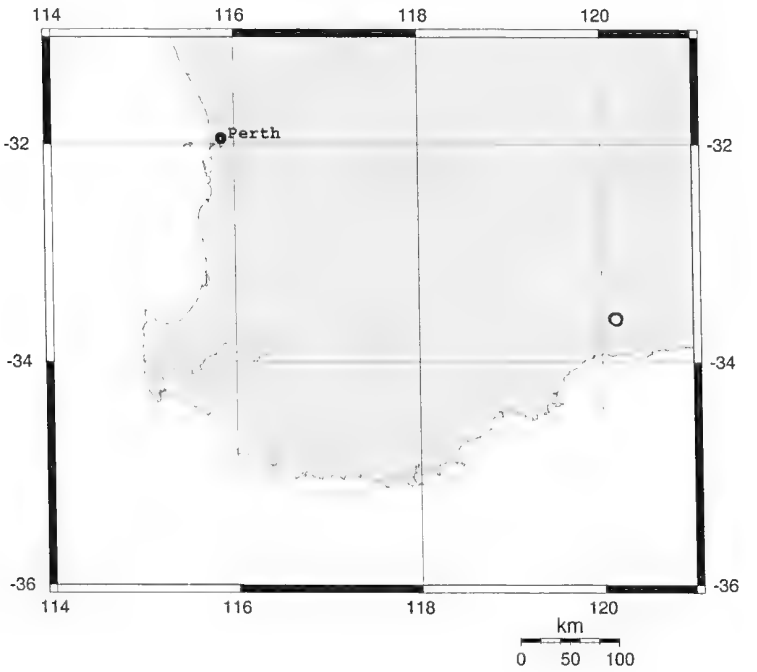

Figure 6. Distribution of *Guichenotia apetala* A.S.George.

Notes. Some larger, basal leaves of *G. apetala* rarely have five lobes and palmate venation. This is presumed to be a juvenile leaf characteristic, but juvenile plants have not been observed.

Acknowledegments

We gratefully acknowledge the support and provision of facilities by the Western Australian Herbarium curator and staff, and from the School of Plant Biology of the University of Western Australia. Thanks also to the late Lorraine Cobb for the excellent illustrations; Paul Wilson for preparation of the Latin diagnosis, and to insightful reviewers for excellent comments; ABRS and NSF grants for research funding; national herbaria for loan of specimens; and Kelly Shepherd, Juliet Wege, Ryonen Butcher, Ainsley Calladine, Raimond Orifici, Jenny Chappill, and John and Genevieve Wilkins for fieldwork assistance and companionship.

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A new species of *Pultenaea* (Mirbelieae: Fabaceae) from Kundip, Western Australia

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Abstract

Wilkins, C.F., Orthia, L.A. & Crisp, M.D. A new species of *Pultenaea* (Mirbelieae: Fabaceae) from Kundip, Western Australia. *Nuytsia* 19(1): 191–196 (2009). A new species *Pultenaea craigiana* C.F.Wilkins, Orthia & Crisp is described. It has affinity to *P. brachytropis* Benth. This species is endemic to the south-west of Western Australia and is a priority species for conservation. Conservation notes and a distribution map are provided.

Introduction

Pultenaea Sm. is restricted to the south-west of Western Australia, and the south and east of Australia. The plants are shrubs occurring in forest, woodland, shrubland or heathland on oligotrophic soils. Common names include 'egg and bacon peas' and 'bush peas'. As currently circumscribed, the genus includes 26 species in south-west Western Australia, 87 species east of the Nullarbor Plain and four species occurring both sides of the Nullabor Plain (de Kok &West 2002, 2003, 2004; Orthia *et al.* 2005a).

A recent cladistic analysis of DNA sequences (Orthia *et al.* 2005b) showed no support for monophyly of *Pultenaea* and the species fell into six well supported but separate lineages. The authors suggested either recognising each of the distinct phylogenetic units as separate genera, or combining all *c.* 470 species of the 'Mirbelia' group of genera into an expanded concept of *Pultenaea* (Orthia *et al.* 2005b, 2005c). However, no formal changes to genera in this group have been made yet and *Pultenaea* retains its previous circumscription pending further research. *Pultenaea* sp. Kundip (G.F. Craig 6008) was discovered after the revision of Orthia *et al.* (2005a) was completed. It requires urgent description as a priority species for conservation due to its restricted distribution and presence on a mining lease. A molecular phylogenetic analysis of trnL-F sequences from cpDNA (unpublished data) grouped *P.* sp. Kundip (G.F. Craig 6008) weakly with *P. brachytropis* Benth., and not with any of the six main clades of *Pultenaea* found by Orthia *et al.* (2005b). The species is here placed in *Pultenaea* until further research is completed (M.D. Crisp in progress).

Methods

The description is based on herbarium specimens from PERTH and UWA. Distribution maps were compiled using the Online Map Creation website (http://www.aquarius.geomar.de/omc_intro.html).

Key to relatives of *Pultenaea craigiana* in Western Australia (modified from Orthia *et al.* 2005a)

The following species share these features. *Stipules* fused to at least one third of their length behind the petiole. *Two upper calyx lobes* are fused for almost their entire length, and the sinus between them < sinus between the lower lobes; *upper lobes* ± triangular or narrowly triangular and widest at the base. *Ovaries and pods* glabrous inside. Numbering of couplets follows Orthia *et al.*

19. Leaf margins recurved ..... **P. brachytropis**
19: Leaf margins incurved ..... **20.**

20. Bracteoles tridentate, with free stipules ..... **P. vestita**
20: Bracteoles ovate, without free stipules ..... **21.**

21. Leaf with a sharp apical point ..... **P. juniperina**
21: Leaf without a sharp point ..... **21a.**

21a. Leaf straight or gently incurved towards an acute apex ..... **P. tenuifolia**
21a: Leaf recurved in upper third; apex clavate, obtuse ..... **P. craigiana**

Species description

Pultenaea craigiana C.F.Wilkins, Orthia & Crisp, *sp. nov.*

B. brachytropi Benth. floribus inflorescentiisque et stipulis connatis similis sed lamina folii marginibus involutis nec recurvis differt.

Typus: southern limit of Ravensthorpe Range, Western Australia, [precise locality withheld for conservation reasons], 5 November 2004, *G.F. Craig* 6148 (*holo*: PERTH 07854765; *iso*: CANB; MEL).

Pultenaea sp. Kundip (G.F. Craig 6008), Western Australian Herbarium, in *FloraBase*, http://florabase.dec.wa.gov.au [accessed 16 March 2008].

Shrub upright, spindly, rounded, 0.15–0.5(–1) high, 0.3–0.5 m wide. *Branchlets* apically with dense, appressed, white, straight hairs *c.* 0.2–0.3 mm long, glabrescent, without tubercles, not spinescent, ascending. *Stipules* red-brown becoming black, persistent, the bases fused to each other across the stem, 0.6–1.3 × 0.3–0.5 mm. *Leaves* divergent or ascending, spirally arranged, longer than internodes, *petiole* pulvinate, cream, 0.4–0.8 mm long; *blade* narrowly-obovate to obovate, 1.3–8 × 0.5–0.9 mm, involute; abaxial surface yellow-green, with scattered, white, appressed hairs on new growth, shortly glabrescent; adaxial surface concealed; apex clavate, obtuse, with apical 1/3 of leaf recurved.

Flowers axillary, solitary, but grouped towards apex. *Bracts* absent, each flower subtended by a leaf and stipules. *Peduncle* absent. *Pedicels* straight, 0.2–0.5 mm long. *Buds* 2.5–4.5 × 1.5–2.5 mm, with scattered, appressed or spreading, straight, white hairs 0.2–0.35 mm long, bud apex rounded, apiculum absent. *Bracteoles* persistent just below the calyx, red-brown, ovate, 0.9–1.3 × 0.4–0.6 mm, margin denticulate, apex acute. *Hypanthium* 0.4–0.6 mm long. *Calyx* not prominently ribbed; lobes asymmetrical, the abaxial three imbricate in bud, adaxial two valvate; tube green; lobes red with a dark red marking at junction present or absent; adaxial lobes falcate, 0.5–0.6 × 1–1.3 mm, fused for 2–3.9 mm; middle and lateral abaxial lobes 1.5–2.4 × 0.7–1.2 mm, fused for 1.0–1.8 mm; apex of all lobes acute. *Standard* with a claw 2–3.3 × 0.5–0.6 mm; lamina yellow with flares of red following veins on upper surface surrounding a basal, ovate, pale lemon eye, broadly ovate, non-auriculate, 3.5–4.2 × 5.3–8.2 mm, emarginate indentation 0.2–0.4 mm deep. *Wings* with a claw1.5–2 × 0.4–0.5 mm; lamina with an adaxial spur; lamina centre with red markings, towards apex yellow, straight, oblong, or scarcely obovate, 4–4.3 × 1.4–1.8 mm; apex rounded. *Keel* with a claw 1.4–1.7 × 0.5 mm; lamina dark red fading to the base, and tip with narrow yellow margin; straight, scarcely obovate, 3.3–5.5 × 1.3–2.1 mm; apex rounded. *Stamen* filaments progressively shorter from adaxial to abaxial filament, and alternating at base scarcely narrower and broader, 1.7–4.6 × 0.1–0.2 mm; *anthers* cream, adaxial anther *c.* 0.2 × 0.2 mm, remainder 0.3–0.4 × 0.25–0.35 mm. *Gynoecium* without a stipe; *ovary* 1.1–1.2 × 0.4–0.7 mm, laterally flattened, with dense, appressed, straight, white hairs *c.* 0.4 mm long, evenly distributed; *style* hooked, 1.5–2.1 × 0.2–0.25 mm, with scattered hairs throughout; *stigma* capitate; *ovules* two, funicle *c.* 0.1 mm long. *Pod* ellipsoid, inflated, apically dehiscent, 3.6–4.3 × 2.2–2.6 mm, the outer surface with sparse, white, appressed hairs to 0.8 mm long over smaller hairs; the inner surface glossy, glabrous. *Seed* one per pod, ovoid, smooth, pale greenish-brown with black, irregular markings, 2–2.1 × 1.1–1.3 mm; *aril* yellow-white, translucent and surrounding the hilum, *c.* 1.1 × 0.7 mm. (Figures 1, 2)

Selected specimens. WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] W of Ravensthorpe–Hopetoun Road, Kundip, 21 Sep. 2005, *S. Barrett* 1403, (PERTH); E of old Kundip townsite, 1 Oct. 2004, *K. Bennett s.n.* (PERTH); Tectonic Resources Mining lease, Kundip, S of Ravensthorpe, 13 Dec. 2004, *J.A. Cochrane & K. Bennett* JAC 5217 (K, PERTH); Southern sector of Kundip Mining leases, E of Kundip, 11 Dec. 2003, *G.F. Craig* 6008 (CANB, PERTH); E of Kundip, southern limit of Ravensthorpe Range, 11 Nov. 2004, *G.F. Craig* 6152 (CANB, PERTH); Ravensthorpe Range, Bonnymidgup Track, 1 Aug. 2007, *G.F. Craig* 8324 (PERTH); Kundip, 2003, *Landcare Services* LCS 10302, (PERTH); Ravensthorpe Range, ESE of Ravensthorpe, towards Jerdacuttup River, 22 Apr. 2007, *S.Kern, R. Jasper, D. Brassington* LCH 16745 (PERTH); W of Floater Road, Ravensthorpe Range, NNW of Ravensthorpe, 28 May 2007, *S.Kern, R. Jasper, D. Brassington* LCH 17139 (PERTH).

Distribution. Pultenaea craigiana is endemic to Western Australia and has a restricted distribution in the Ravensthorpe Range. It is known only from the northern area of the range and in the vicinity of the old Kundip township, in the Kundip mining lease. (Figure 3)

Habitat. This species has been collected in calcareous pale grey, or brown loam and silcrete over felsic Kybulup schist and quartz gravel, in a burnt Mallet thicket and in *Eucalyptus astringens* woodland with very open heath, or sparse shrubland. North of Ravensthorpe it has been collected in *Eucalyptus platypus* regrowth which had been scrub-rolled and burnt three years previously.

Phenology. Flowering August to November; fruiting December.

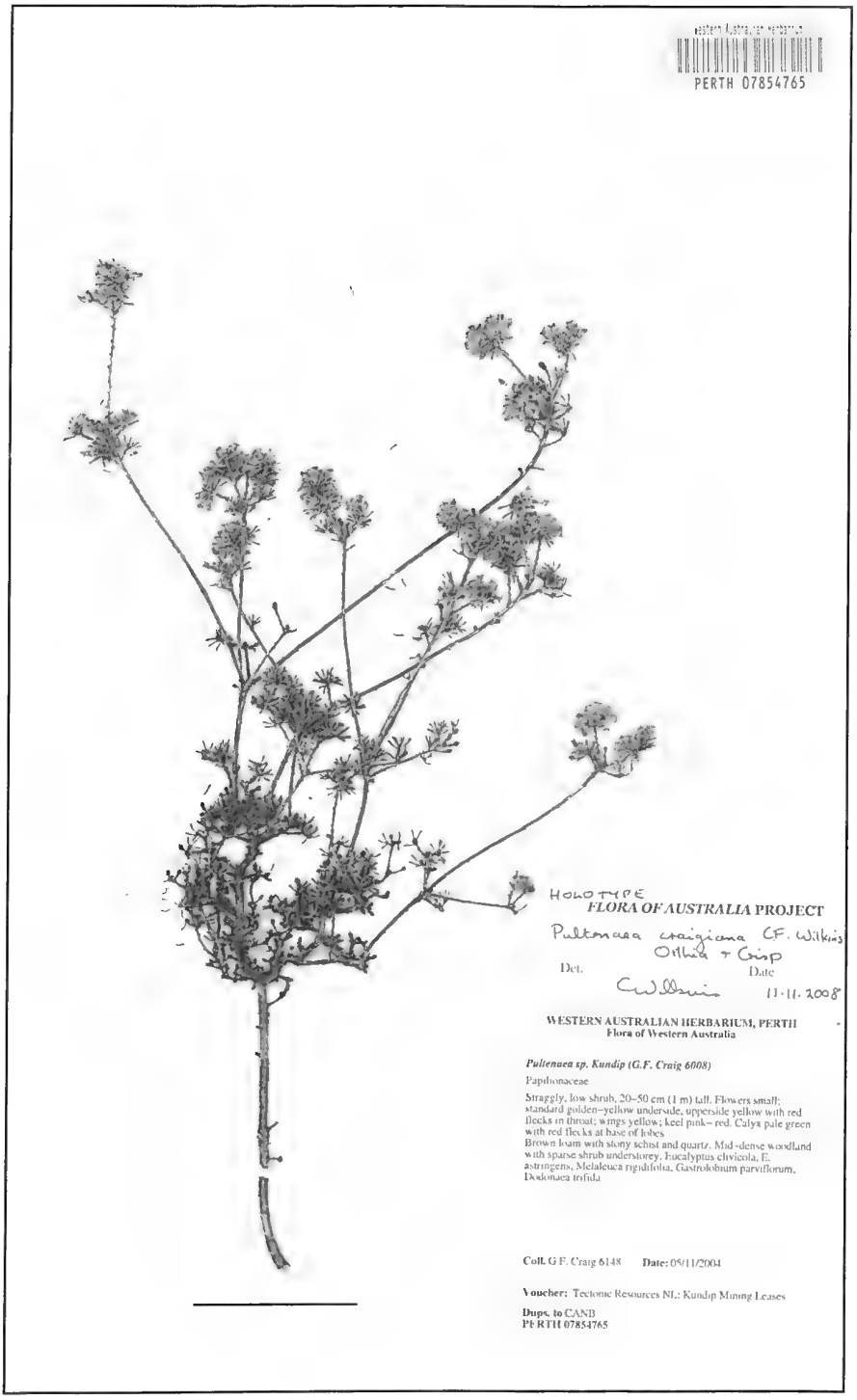

Figure 1. Holotype of *Pultenaea craigiana* C.F.Wilkins, Orthia & Crisp (PERTH 07814765), scale = 5 cm.

Figure 2. *Pultenaea craigiana*. A – habit; B – flowers. (*G. F. Craig* 6148). Photographs by G. Craig.

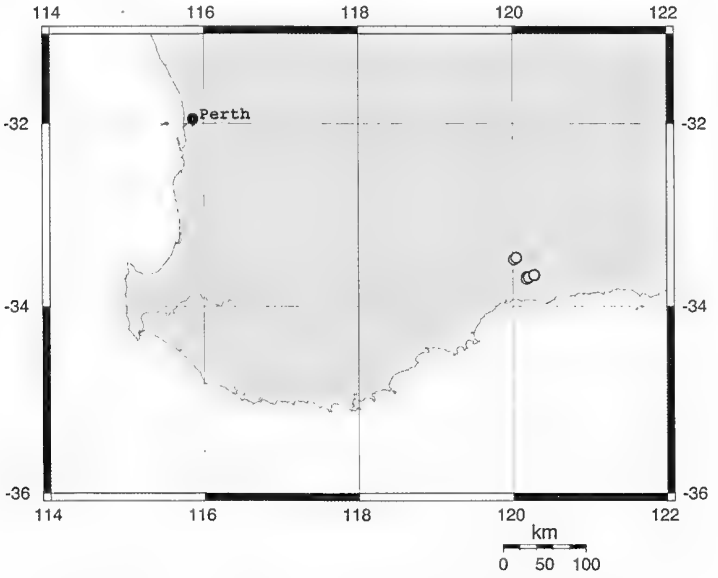

Figure 3. Distribution of *Pultenaea craigiana* (○) in Western Australia.

Conservation status. Abundant in burnt regrowth and rare in old-growth areas. Currently listed as Priority One, as *Pultenaea* sp. Kundip (G.F. Craig 6008) under the Department of Environment and Conservation's Conservation Codes for Western Australia (Atkins 2008).

Etymology. The specific epithet honours Dr Gillian Craig, the botanist who discovered this new species, and who has made a significant contribution to the conservation of Western Australian flora, especially in the Ravensthorpe area, by undertaking floristic surveys and coastal management programmes.

Notes. Pultenaea craigiana is possibly most closely related to *P. brachytropis*, which it closely resembles in the fused stipules and in floral and inflorescence characters, e.g. the blunt, red-tipped calyx. However, these two species are easily distinguished by the leaf blades, which have involute margins in *P. craigiana* and strongly recurved margins in *P. brachytropis*. *Pultenaea calycina* subsp. *proxena* Orthia & Chappill has similar leaves to *P. craigiana* and occurs in the Ravensthorpe area. *Pultenaea craigiana* differs from *P. calycina* subsp. *proxena* in having leaves that are involute, rather than strongly incurved and the stipules are fused together at the base rather than free. The calyx upper lobes are also less rotund and the lower three lobes are more developed.

Acknowledgements

We thank Gillian Craig for drawing our attention to this species and adding helpful notes to this paper, and to Gillian and Rosemary Jasper for supplying specimens and information.This project was supported by the Department of Environment and Conservation in Western Australia.

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SHORT COMMUNICATIONS

Recombination of subspecies in *Trihaloragis* (Haloragaceae)

Moody and Les (2007) recognized the genus *Trihaloragis* consisting of the single species *Trihaloragis hexandra* (F.Muell.) M.L.Moody & D.H.Les. Recombination of the three subspecies of *Haloragis hexandra* was overlooked at the time. Here new combinations of the three subspecies are presented.

Trihaloragis hexandra (F.Muell.) M.L.Moody & D.H.Les subsp. **hexandra** Synonym: *Haloragis hexandra* F.Muell., *Fragm.* 3(18): 31(1862); *Gonocarpus hexandrus* (F.Muell.) Orchard subsp. *hexandrus*, *Bull. Auckland Inst. Mus.* 10: 257 (1975).

Trihaloragis hexandra subsp. **integrifolia** (Schindl.) M.L.Moody *comb. nov.* Basionym: *Haloragis hexandra* var. *integrifolia* Schindl. in H.G.A. Engler, *Pflanzenr.* 23: 54 (1905). Synonym: *Gonocarpus hexandrus* subsp. *integrifolius* (Schindl.) Orchard, *Bull. Auckland Inst. Mus.*10: 259 (1975).

Trihaloragis hexandra subsp. **serrata** (Schindl.) M.L.Moody *comb. nov.* Basionym: *Haloragis hexandra* var. *serrata* Schindl. in H.G.A. Engler, *Pflanzenr.* 23: 54 (1905). Synonym: *Gonocarpus hexandrus* subsp. *serratus* (Schindl.) Orchard, *Bull. Auckland Inst. Mus.* 10: 259 (1975).

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Moody, M.L. & Les, D.H. (2007). Phylogenetic systematics and character evolution in the angiosperm family Haloragaceae. *American Journal of Botany* 94(12): 2005–2025.

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Clarification of recent combinations in the genus *Dysphania* (Chenopodiaceae)

In a paper commenting on the generic status of the Chenopodiaceae, Wilson (1987) noted an affinity between the representatives of *Chenopodium* L. subg. *Ambrosia* A.J.Scott and the genus *Dysphania* R.Br., based on the presence of both septate and glandular hairs as well as similarities in leaf shape, leaf venation, inflorescence structure and seed orientation. Mosyakin and Clemants (2002) later came to a similar conclusion and reassigned the North American representatives (both endemic and naturalised) of *Chenopodium* subg. *Ambrosia* to *Dysphania*. More recent molecular studies have provided further evidence of this relationship (Kadereit *et al.* 2003, 2005) and Shepherd and Wilson (2008) therefore proposed that the Australian and New Zealand representatives of *Chenopodium* subg. *Ambrosia* sect. *Orthosporum* should also be transferred to *Dysphania* (see Table below). Although the Shepherd and Wilson manuscript was accepted for publication in the journal *Nuytsia* in February 2008, it was not published until August of that year. A paper by Mosaykin and Clemants (2008) making all of the same combinations with the exception of *Chenopodium melanocarpum* f. *leucocarpum* (Aellen) Paul G.Wilson, was published in July 2008. As Mosaykin and Clemants (2008) antedates Shepherd and Wilson (2008) their combinations are accepted. The correct authorities for the relevant taxa are given below to avoid any confusion.

Shepherd & Wilson (August 2008)	Correct names
Dysphania melanocarpa (J.M.Black) Paul G.Wilson & K.A.Sheph.	***Dysphania melanocarpa*** (J.M.Black) Mosyakin & Clemants, J. Bot. Res. Inst. Texas 2: 427 (July 2008)
Dysphania melanocarpa f. ***leucocarpa*** (Aellen) Paul G.Wilson & K.A.Sheph.	***Dysphania melanocarpa*** f. ***leucocarpa*** (Aellen) Paul G.Wilson & K.A.Sheph.
Dysphania pusilla (Hook.f.) Paul G.Wilson & K.A.Sheph.	***Dysphania pusilla*** (Hook.f.) Mosyakin & Clemants, *l.c.*
Dysphania truncata (Paul G.Wilson) Paul G.Wilson & K.A.Sheph.	***Dysphania truncata*** (Paul G.Wilson) Mosyakin & Clemants, *l.c.*
Dysphania saxatilis (Paul G.Wilson) Paul G.Wilson & K.A.Sheph.	***Dysphania saxatilis*** (Paul G.Wilson) Mosyakin & Clemants, *l.c.*

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Mosyakin, S.L. & Clemants, S.E. (2008). Further transfers of glandular-pubescent species from *Chenopodium* subg. *Ambrosia* to *Dysphania* (Chenopodiaceae). *Journal of the Botanic Research Institute of Texas* 2(1): 425–431.

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Referees for Volume 19(1)

The assistance of referees in providing expert review of papers submitted to *Nuytsia* is gratefully acknowledged. The referees consulted for Volume 19 include those listed below. Each paper was also refereed internally by *Nuytsia* Editorial Committee members.

Tony Bean
Barbara Briggs
Ian Brooker
Bob Chinnock
Ian Cowie
Alex George
Peter Jobson
Kristina Lemson
Hannah McPherson
Barbara Rye
Kelly Shepherd
Frank Udovicic

Corrections to *Nuytsia* Volume 18

Page 99. Under heading *Typification,* 2nd paragraph, line 1: replace 0052966 with 00529966.

Page 199. Under heading **Eucalyptus conferruminata,** subheading *Type*: barcode PERTH 01377701 is the holotype.

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA

R: Declared Rare Flora – Extant Taxa (= Threatened Flora= Endangered+ Vulnerable) Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Threatened Species Scientific Committee.

X: Declared Rare Flora – Presumed Extinct Taxa Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searhcing, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for Environment, after recommendation by the State's threatened Species Scientific Committee.

1: Priority One – Poorly Known Taxa Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral aniamls, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two – Poorly Known Taxa Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three – Poorly Known Taxa Taxa which are known from several populations, at least some of which are not believed tobe under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

4: Priority Four – Rare Taxa Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.

Publication date for Nuytsia Volume 18: 21 August 2008

NOTES FOR AUTHORS

Nuytsia publishes original papers and short communications on systematics, taxonomy and nomenclature of Australian (particularly Western Australian) plants, algae and fungi, with preference given to papers dealing with new taxa, revisions, systematic analyses and classifications, censuses, invasive species, and nomenclatural and taxonomic issues. Book reviews will not be accepted. All papers are peer reviewed and should not be under consideration elsewhere. No page charges apply.

Authors should read and follow the comprehensive guidelines for authors available at http://science.dec.wa.gov.au/nuytsia, paying particular attention to the following:

Manuscript format. Double-sided with 1.5-line spacing throughout. All text should be in the typeface (bold, italic etc.) in which it will be published. Manuscripts may be submitted by email, in MS-Word format.

Title. Should be concise and include the family name of genera or species treated (but not authorities) and geographic scope where appropriate. New taxa should be named if not numerous. Full author's names should follow the title, followed by institutional addresses keyed by superscripted letters. An email address should be given for the Corresponding Author, if possible.

Abstract. Must comprise a single paragraph and provide a stand-alone summary of the paper for abstracting services. All new names and combinations made in the paper should be listed if possible.

Names. Nomenclatural authorities must be provided for first instances of all taxonomic names below the rank of family, both in the Abstract and in the body of the text.

Headings. Principal headings should be bold and centred; second-order headings should be italicized, left-justified and separated from the following text by a stop without paragraph break.

Keys. May be either indented (e.g. *Nuytsia* 18: 45) or bracketed (e.g. *Nuytsia* 18: 149). Indented keys involving more than nine levels of indentation should be avoided.

Conservation status. Conservation Codes as used by the Department of Environment and Conservation should be recommended for rare and threatened taxa; these will be assessed by Department staff during review of the paper. Precise localities and georeferences should not be given for Declared Rare and Priority taxa; instead, cite generalized localities only, accompanied by the statement "[Precise localities withheld for conservation reasons]".

Abbreviations. The following standards are used for abbreviations:

- Nomenclatural authors: *Authors of Plant Names* (Brummitt & Powell 1992).
- Bibliographic references (nomenclatural sections only): *Taxonomic Literature II* (Stafleu & Cowan 1976–1986; Stafleu & Mennega 1992–) for books; *Botanico-Periodicum-Huntianum* (Lawrence *et al.* 1968) for journals.
- Herbaria: *Index Herbariorum* (Holmgren *et al.* 1990).

References. Citations in the text should be of the form *Author's Surname(s) (year) [or (year: page)]* with full details given in the Reference section. Use an ampersand to separate two authors, and *First Author et al.* for three or more authors. Citations in the References section should be of the forms:

- *Journal article*: Butcher, R. (2007). New 'leafless' *Tetratheca* (Elaeocarpaceae, formerly Tremandraceae) taxa from Western Australia. *Australian Systematic Botany* 20(2): 139–160.
- *Book*: Paczkowska, G. & Chapman, A.R. (2000). *The Western Australian flora: a descriptive catalogue.* (Wildflower Society of Western Australia: Nedlands, WA.)
- *Chapter in a book*: Rye, B.L. (1992). Myrtaceae. *In*: Wheeler, J.R. (ed.) *Flora of the Kimberley Region.* pp. 499–546. (Western Australian Herbarium: Perth.)
- *Website*: Western Australian Herbarium (1998–). *FloraBase – The Western Australian flora.* Department of Environment and Conservation. http://florabase.dec.wa.gov.au/ [accessed May 2008]

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Main papers

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